THE

JOURNAL

OF THE

ROYAL AGRICULTURAL SOCIETY

OF ENGLAND.

VOLUME THE TWENTY-FIRST.

PRACTICE WITH SCIENCE.

LONDON:
JOHN MURRAY, ALBEMARLE STREET.
1860.

THESE EXPERIMENTS, IT IS TRUE, ARE NOT EASY; STILL THEY ARE IN THE POWER OF EVERY THINKING HUSBANDMAN. HE WHO ACCOMPLISHES BUT ONE, OF HOWEVER LIMITED APPLICATION, AND TAKES CARE TO REPORT IT FAITHFULLY, ADVANCES THE SCIENCE, AND, CONSEQUENTLY, THE PRACTICE OF AGRICULTURE, AND ACQUIRES THEREBY A RIGHT TO THE GRATITUDE OF HIS FELLOWS, AND OF THOSE WHO COME AFTER. TO MAKE MANY SUCH IS BEYOND THE POWER OF MOST INDIVIDUALS, AND CANNOT BE EXPECTED. THE FIRST CARE OF ALL SOCIETIES FORMED FOR THE IMPROVEMENT OF OUR SCIENCE SHOULD BE TO PREPARE THE FORMS OF SUCH EXPERIMENTS, AND TO DISTRIBUTE THE EXECUTION OF THESE AMONG THEIR MEMBERS.

VON THAER, *Principles of Agriculture.*

CONTENTS OF VOL. XXI.

APPENDIX.

DIRECTIONS TO THE BINDER.

The Binder is desired to collect together all the Appendix matter, with Roman numeral folios, and place it at the *end* of each volume of the Journal, excepting Titles and Contents, and Statistics, &c., which are in all cases to be placed at the *beginning* of the Volume: the lettering at the back to include a statement of the *year* as well as the *volume*; the first volume belonging to 1839–40, the second to 1841, the third to 1842, the fourth to 1843, and so on.

In Reprints of the Journal all Appendix matter (and in one instance an Article in the body of the Journal), which at the time had become obsolete, were omitted; the Roman numeral folios, however (for convenience of reference), being reprinted without alteration in the Appendix matter retained.

CONTENTS OF PART I., VOL. XXI.

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STATISTICS

OF

THE WEATHER, PUBLIC HEALTH, PRICE OF PROVISIONS, &c., &c.,

FOR THE SIX MONTHS ENDING JUNE 30, 1860.

Chiefly extracted from the Quarterly Report of the Registrar-General.—The Corn Returns and Diagram are prepared from Official Documents expressly for this Journal.

ON

THE METEOROLOGY OF ENGLAND

DURING

THE QUARTER ENDING MARCH 31, 1860.

By JAMES GLAISHER, Esq., F.R.S.,

SEC. OF THE BRITISH METEOROLOGICAL SOCIETY.

The weather during this quarter was remarkable for a long continuance of low temperature, frequent and great changes in the pressure of the atmosphere, and an almost continuous succession of gales of wind.

The warm period which set in on December 24, 1859, continued to January 24, 1860; the excess of the temperature from January 1st to the 24th averaged 4°·1 daily; on the 25th a cold period set in, which at first was not severe, but became so afterwards, and continued, with very few and trifling exceptions, to the end of the quarter. The average defect of the 67 days ending March 31 was 1½° daily below the average. Both the days and nights in January were warm; in February both cold, particularly the nights; and both were cold in March, but the nights less so than the days.

The mean temperature of the three months was 38°·8; that of February, the coldest month, 35°·7; of March, 41°·1, but little warmer on the average than that of January, 39°·7.

The mean pressure of the atmosphere in January and March was below its average by ¼ inch; in February it was slightly in excess on comparison with the preceding 19 years, and within this period the mean reading of the barometer has not been so low in January as it was in this year.

The temperature of the dew-point in January was ¾° in excess, differing but little from the excess of the mean temperature of the month, and therefore the degree of humidity was very nearly that of the average for the month. In February and March the temperature of the dew-point was more below its average than that of the air, and therefore the air was in both months more than usually dry.

The fall of rain was slightly below the average. Gales of wind of unusual duration were frequent throughout the quarter.

The mean temperature of the air at Greenwich for the three months ending February, constituting the three winter months, was 37°·4, being 0°·4 below the average of 89 years.

THE WEATHER DURING THE QUARTER ENDING MARCH 31, 1860.

1860. MONTHS.	Temperature of Air. Mean.	Air. Diff. from average of 89 years.	Air. Diff. from average of 19 years.	Evaporation. Mean.	Evaporation. Diff. from average of 19 years.	Dew Point. Mean.	Dew Point. Diff. from average of 19 years.	Air—Daily Range. Mean.	Air—Daily Range. Diff. from average of 19 years.	Elastic Force of Vapour. Mean.	Elastic Force of Vapour. Diff. from average of 19 years.	Weight of Vapour in a Cubic Foot of Air. Mean.	Weight of Vapour. Diff. from average of 19 years.
	°	°	°	°	°	°	°	°	°	in.	in.	grs.	gr.
January ..	39·7	+3·6	+1·5	38·2	+1·1	36·2	+0·8	10·2	+0·7	·214	+·009	2·5	+0·1
February ..	35·7	−2·6	−2·8	33·6	−3·4	30·4	−4·2	12·4	+1·1	·170	−·032	2·0	−0·3
March ..	41·1	+0·2	−0·7	38·4	−1·0	35·0	−1·4	14·2	−0·5	·204	−·013	2·4	−0·1
Mean ..	38·8	+0·4	−0·7	36·7	−1·1	33·9	−1·6	12·3	+0·4	·196	−·012	2·3	−0·1

1860. MONTHS.	Degree of Humidity. Mean.	Degree of Humidity. Diff. from average of 19 years.	Reading of Barometer. Mean.	Reading of Barometer. Diff. from average of 19 years.	Weight of a Cubic Foot of Air. Mean.	Weight of a Cubic Foot of Air. Diff. from average of 19 years.	Rain. Amount.	Rain. Diff. from average of 45 years.	Temperature of Water of the Thames.	Reading of Thermometer on Grass. Number of Nights it was At or below 30°.	Between 30° and 40°.	Above 40°.	Lowest Reading at Night.	Highest Reading at Night.
			in.	in.	grs.	grs.	in.	in.	°				°	°
January ..	88	−1	29·514	−·248	548	−6	1·8	0·0	42·1	15	13	3	18·3	48·0
February ..	80	−6	29·857	+·074	559	+5	1·1	−0·5	36·6	26	3	0	9·5	33·5
March ..	79	−3	29·655	−·145	549	−2	1·9	+0·4	42·3	17	11	3	21·0	45·0
Mean ..	82	−3	29·675	−·106	552	−1	Sum 4·8	Sum −0·1	Mean 40·3	Sum 58	Sum 27	Sum 6	Lowest 9·5	Highest 48·0

NOTE.—In reading this table it will be borne in mind that the sign (−) minus signifies below the average, and that the sign (+) plus signifies above the average.

ON

THE METEOROLOGY OF ENGLAND

DURING

THE QUARTER ENDING JUNE 30, 1860.

By JAMES GLAISHER, Esq., F.R.S.,

SEC. OF THE BRITISH METEOROLOGICAL SOCIETY.

The cold weather which set in on January 25, and which was prevalent to the end of the last quarter, continued, excepting the 19 days following May 8, till the end of the present quarter.

The mean daily deficiency of temperature for the 38 days beginning April 1 amounted to $3\frac{1}{4}°$, and for the 34 days ending June 30 was as large as $4\frac{1}{4}°$; the average daily deficiency for these 72 days was $3\frac{1}{2}°$. The remaining 19 days, viz., from May 8 to May 26, were warm, and their temperatures were daily in excess of the average to the amount of $3\frac{1}{2}°$.

Both the days and nights in April were remarkably cold, and to an almost equal amount; in May both were somewhat warmer than usual; and in June both were cold, particularly the days, the mean temperature of which was lower than in May, although it is usually higher to the amount of 7 degrees.

The temperature of April was 3°·6 in defect; that of May 1°·0 in excess; that of June 4°·4 in defect, as compared with the averages of the preceding 19 years. The month of April was colder than any April since the year 1839, and we must travel back to the year 1821 to find so cold a June.

The mean pressure of the atmosphere in April was a little above, in May a little below, and in June much below, the average.

The range of the barometer readings at extreme southern stations was 1·2 inch in April; 1·0 inch in May; and somewhat less than an inch in June; these values gradually increased on going northward to 1·9 inch in April; to 1·3 inch in May: and somewhat more than an inch in June at extreme northern stations.

The temperature of the dew point in April was 3°·4 in defect, being very nearly the same in amount as that of the air; and therefore the degree of humidity was of its average value; in May it was 0·8 in excess, being somewhat less than the excess of temperature of the air, and the air was slightly drier than the average; in June its defect was 1°·3, whilst that of the air was 4°·4, so that the air in June was remarkably humid.

The fall of rain at Greenwich in April was 0·8 inch in defect; in May 1·8 inch in excess, and in June 3·9 inches in excess. The total fall was 10·7 inches, being 4·9 inches over the average for this quarter. Gales of wind have been frequent during the quarter.

The mean temperature of the air at Greenwich, for the three months ending May, constituting the three spring months, was 45°·9, being 0°·5 below the average of the preceding 89 years.

THE WEATHER DURING THE QUARTER ENDING JUNE 30, 1860.

1860. MONTHS.	Temperature of Air. Mean.	Air. Diff. from average of 89 years.	Air. Diff. from average of 19 years.	Evaporation. Mean.	Evaporation. Diff. from average of 19 years.	Dew Point. Mean.	Dew Point. Diff. from average of 19 years.	Air—Daily Range. Mean.	Air—Daily Range. Diff. from average of 19 years.	Elastic Force of Vapour. Mean.	Elastic Force of Vapour. Diff. from average of 19 years.	Weight of Vapour in a Cubic Foot of Air. Mean.	Weight of Vapour. Diff. from average of 19 years.
	°	°	°	°	°	°	°	°	°	in.	in.	grs.	gr.
April ..	42·9	−2·9	−3·6	40·1	−3·4	36·7	−3·4	18·1	−0·1	·218	−·031	2·5	−0·4
May	53·8	+1·3	+1·0	50·0	+0·9	46·2	+0·8	20·9	+0·7	·313	+·013	3 5	+0·1
June ..	54·8	−3·3	−4·4	52·2	−2·7	49·7	−1·3	16·5	−4·8	·357	−·017	4·0	−0·2
Mean ..	50·5	−1·6	−2·3	47·4	−1·7	44·2	−1·3	18·5	−1·4	·296	−·012	3·3	−0·2

1860. MONTHS.	Degree of Humidity. Mean.	Degree of Humidity. Diff. from average of 19 years.	Reading of Barometer. Mean.	Reading of Barometer. Diff. from average of 19 years.	Weight of a Cubic Foot of Air. Mean.	Weight of a Cubic Foot of Air. Diff. from average of 19 years.	Rain. Amount.	Rain. Diff. from average of 45 years.	Temperature of Water of the Thames.	Reading of Thermometer on Grass. Number of Nights it was At or below 30°.	Between 30° and 40°.	Above 40°.	Lowest Reading at Night.	Highest Reading at Night.
			in.	in.	grs.	grs.	in.	in.	°				°	°
April ..	79	0	29·796	+·064	549	+5	1·0	−0·8	46·2	13	16	1	19·8	41·0
May	75	−1	29·746	−·016	536	−2	3·9	+1·8	54·0	2	16	13	26·8	49·7
June ..	82	+9	29·613	−·190	532	+1	5·8	+3·9	59·2	0	3	27	30·3	55·0
Mean ..	79	+3	29·718	−·047	539	+1	Sum 10·7	Sum +4·9	Mean 53·1	Sum 15	Sum 35	Sum 41	Lowest 19·8	Highest 55·0

NOTE.—In reading this table it will be borne in mind that the sign (−) minus signifies below the average, and that the sign (+) plus signifies above the average.

STATE OF THE PUBLIC HEALTH.

1*st Quarter*.—122,642 deaths were registered in this quarter. The mortality was about 2·472 per cent., or slightly above (2·460) the average of this season—in the absence of epidemics always the most fatal in England. The rate of mortality in the chief town districts was 2·613; in the small town and country districts 2·338 per cent. The latter rate is above, the former below, the average of those districts respectively. The deaths in the quarter, at the rates actually prevailing in the healthier districts of the country, would only have amounted to 88·708. Consequently, the deaths from causes induced by the unfavourable sanitary condition in which large numbers of the people live, amount to 33,934.

2*nd Quarter*.—The deaths registered in the three months that ended June 30th were 110,878, a larger number than was returned in any previous June quarter (1848-59). The annual rate of mortality in the quarter was 2·228 per cent. of the population, while the average of ten previous spring quarters was 2·195. The excess no doubt was caused in some measure by badness of weather and dearness of food. If the mortality had been at the rate of the selected healthy districts instead of the actual rate, the deaths in the whole of England and Wales last quarter would have been 85,283, or 25,595 less than the actual number.

PRICE OF PROVISIONS.

1*st Quarter*.—The average price of wheat was 44*s*. 5*d*. a quarter, while in the corresponding quarters of the two previous years it was respectively 46*s*. 5*d*. and 40*s*. 8*d*. Beef was sold on an average at 5⅛*d*. a pound by the carcase at Leadenhall and Newgate Markets; the average of the highest prices of the best beef having been 6½*d*., of the lowest prices 3¾*d*. The inferior beef was 1*d*. a pound lower than in the winter of the preceding year; so the price fell 21 per cent. The superior beef only fell from 6¾*d*. to 6½*d*. The average price of mutton was 5¾*d*. a pound; inferior mutton 4¾*d*.; superior 6¾*d*. a pound. York Regent potatoes sold on an average at 130*s*. a ton at the Waterside Market, Southwark.

2*nd Quarter*.—Wheat has risen in price; the average in the three months ending June 30th was 52*s*. 8*d*. per quarter. In the same period of last year it was 47*s*. 3*d*., and in that of 1858 it was 44*s*. 1*d*. The dearness both of bread and meat has been sensibly felt by the labouring class. The average price of beef was 5¾*d*. per lb.; that of mutton 6½*d*., as sold by the carcase at Leadenhall and Newgate Markets. York Regent potatoes sold at the Waterside Market, Southwark, at an average price of 142*s*. 6*d*. per ton.

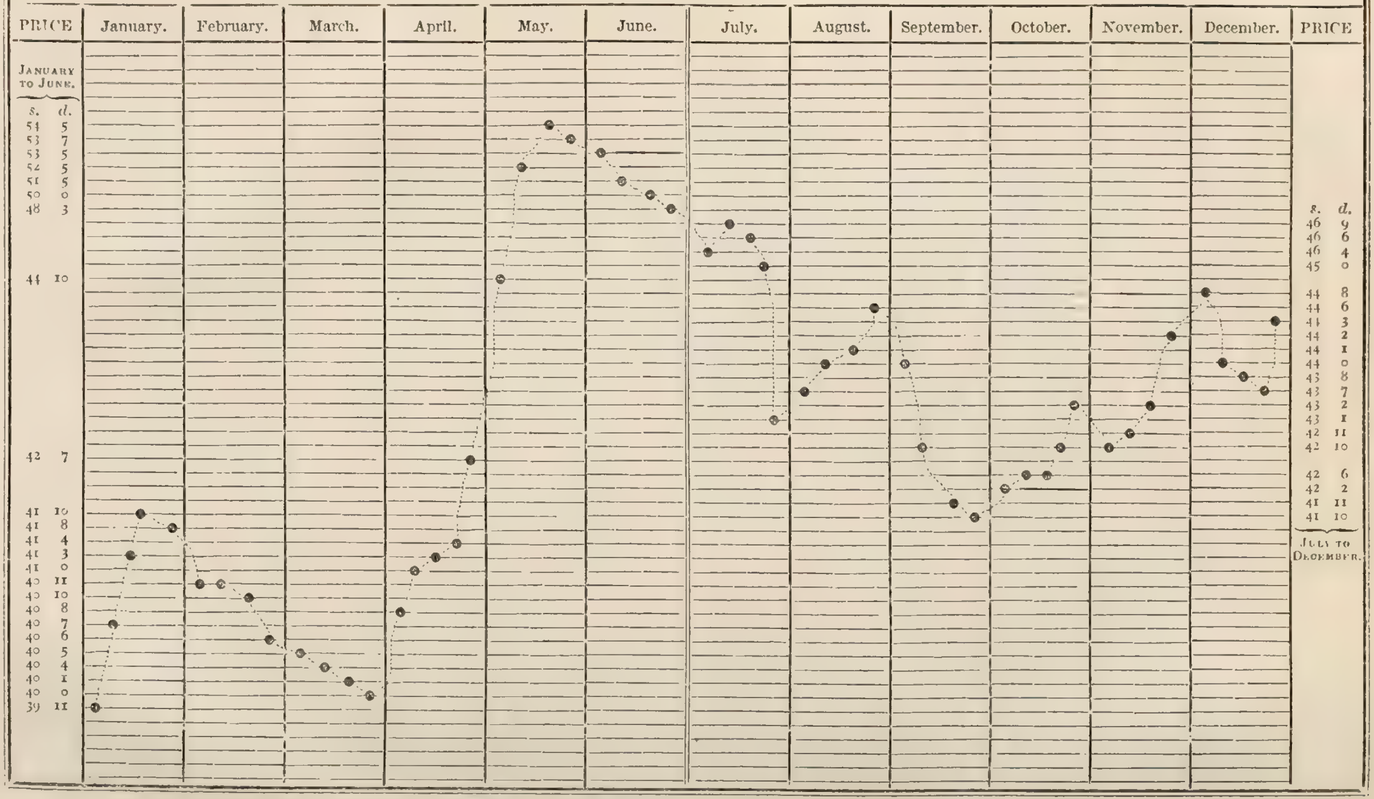
THE PRICE OF PROVISIONS.

The AVERAGE PRICES of Consols, of Wheat, Meat, and Potatoes; also the AVERAGE QUANTITY of Wheat sold and imported weekly, in each of the Nine Quarters ending June 30th, 1860.

Quarters ending	Average Price of Consols (for Money).	Average Price of Wheat per Quarter in England and Wales.		Wheat sold in the 290 Cities and Towns in England and Wales making Returns.*	Wheat and Wheat Flour entered for Home Consumption at Chief Ports of Great Britain.*	Average Prices of Meat per lb. at Leadenhall and Newgate Markets (by the Carcase).		Average Prices of Potatoes (York Regents) per Ton at Waterside Market, Southwark.
				Average number of Quarters weekly.		Beef.	Mutton.	
1858	£.	s.	d.					
June 30	$97\frac{1}{8}$	44	1	92,955	86,551	$4\frac{1}{4}d.$—$6d.$ Mean $5\frac{1}{8}d.$	$4\frac{1}{2}d.$—$6\frac{1}{2}d.$ Mean $5\frac{1}{2}d.$	140s.—185s. Mean 162s. 6d.
Sept. 30	$96\frac{4}{8}$	44	7	97,307	82,373	$4\frac{1}{2}d.$—$6\frac{1}{4}d.$ Mean $5\frac{1}{4}d.$	$4\frac{1}{2}d.$—$6\frac{1}{2}d.$ Mean $5\frac{1}{2}d.$	65s.—90s. Mean 77s. 6d.
Dec. 31	$98\frac{1}{4}$	41	9	110,437	54,413	$4d.$—$6\frac{1}{2}d.$ Mean $5\frac{1}{4}d.$	$4\frac{1}{4}d.$—$6\frac{3}{4}d.$ Mean $5\frac{1}{2}d.$	80s.—95s. Mean 87s. 6d.
1859								
Mar. 31	$95\frac{5}{8}$	40	8	103,637	46,139	$4\frac{3}{4}d.$—$6\frac{3}{4}d.$ Mean $5\frac{3}{4}d.$	$4\frac{3}{4}d.$—$7d.$ Mean $5\frac{7}{8}d.$	80s.—100s. Mean 90s.
June 30	$92\frac{7}{8}$	47	3	96,514	99,533	$4\frac{3}{4}d.$—$6\frac{1}{2}d.$ Mean $5\frac{5}{8}d.$	$5d.$—$7d.$ Mean $6d.$	85s.—110s. Mean 97s. 6d.
Sept. 30	$95\frac{3}{8}$	44	0	85,707	50,291	$4\frac{1}{4}d.$—$6\frac{1}{4}d.$ Mean $5\frac{1}{4}d.$	$4\frac{3}{4}d.$—$6\frac{3}{4}d.$ Mean $5\frac{3}{4}d.$	65s.—105s. Mean 85s.
Dec. 31	$96\frac{1}{8}$	43	4	127,361	44,911	$4d.$—$6\frac{1}{2}d.$ Mean $5\frac{1}{4}d.$	$4\frac{3}{4}d.$—$6\frac{3}{4}d.$ Mean $5\frac{3}{4}d.$	85s.—120s. Mean 102s. 6d.
1860								
Mar. 31	$94\frac{5}{8}$	44	5	114,218	22,300	$3\frac{3}{4}d.$—$6\frac{1}{2}d.$ Mean $5\frac{1}{8}d.$	$4\frac{3}{4}d.$—$6\frac{3}{4}d.$ Mean $5\frac{3}{4}d.$	115s.—145s. Mean 130s.
June 30	$94\frac{7}{8}$	52	8	101,106	62,272	$4\frac{3}{4}d.$—$6\frac{3}{4}d.$ Mean $5\frac{3}{4}d.$	$5\frac{1}{2}d.$—$7\frac{1}{2}d.$ Mean $6\frac{1}{2}d.$	125s.—160s. Mean 142s. 6d.
Col.	1	2		3	4	5	6	7

* NOTE.—The total number of quarters of wheat sold in England and Wales for the 13 weeks ending June 30th, 1858, was 1,208,420; for the 13 weeks ending September 30th, 1858, 1,264,996; for the 13 weeks ending December 31st, 1858, 1,435,678; for the 13 weeks ending March 31st, 1859, 1,347,277; for the 13 weeks ending June 30th, 1859, 1,254,682; for the 13 weeks ending September 30th, 1859, 1,114,191; for the quarter ending December 31st, 1859 (14 weeks), 1,783,050; for the 13 weeks ending March 31st, 1860, 1,484,837; and for the 13 weeks ending June 30th, 1860, 1,314,386. The total number of quarters entered for Home Consumption was respectively, 1,125,165; 1,070,845; 707,367; 599,807; 1,293,925; 653,789; 583,848; 289,906; and 809,535.

1859.—WEEKLY AVERAGE PRICE OF **WHEAT** FROM GOVERNMENT RETURNS.



	Wheat.	Barley.	Oats.	Beans.	Peas.	Maize.	Flour and Meal.
Average of Year	43/10	33/7	23/3	42/4	39/10	..	..
	qrs.	*qrs.*	*qrs.*	*qrs.*	*qrs.*	*qrs.*	*cwt.* *qrs.* *lbs.*
Import of United Kingdom	4,024,178	1,742,065	1,709,197	346,096	157,443	1,321,632	3,358,638 1 5

STATISTICS

OF

THE WEATHER, PUBLIC HEALTH, PRICE OF PROVISIONS, &c., &c.,

FOR THE SIX MONTHS ENDING DECEMBER 31, 1860.

Chiefly extracted from the Quarterly Report of the Registrar-General.—The Corn Returns are prepared from Official Documents expressly for this Journal.

ON

THE METEOROLOGY OF ENGLAND

DURING

THE QUARTER ENDING SEPTEMBER 30, 1860.

BY JAMES GLAISHER, Esq., F.R.S.,

SEC. OF THE BRITISH METEOROLOGICAL SOCIETY.

THE weather during the quarter was very remarkable for continued low temperature, frequent rain, large amount of cloud, little sunshine, and bad weather generally. The temperature within the three months reached its average on 9 days only, and fell short on 83 days; the mean excess on the 9 days was less than $\frac{3}{4}$°; whilst the average daily deficiency for the 83 days exceeded 4°. The mean temperature of July was 4°·3, in August 3°·8, and in September 3°·7, in defect, as compared with their respective averages from the preceding 19 years. As compared with the year 1859, July was 10°·5, August 5°·8, and September 3°·3 colder. The mean temperature of the three months ending September was 56°·2, and once only, viz., in 1817, has the mean temperature of the same months been so low since the year 1771. The mean temperature of the four months ending September is still more remarkable; its value was 55°·9, and there is no other instance, as far as trustworthy records extend, of a temperature of so low a value for these four important months.

The mean pressure of the atmosphere in July was a little above, in August much below, and in September below their respective averages. The pressure in August was less than in any August in the preceding 20 years. The pressure was less in August than in July at extreme southern stations by 0·25 in., increasing gradually to 0·40 in. at northern stations. It was greater in September than in August by 0·15 in. at southern stations, gradually increasing to 0·33 in. at extreme northern stations.

The temperature of the dew-point was below its average in July and August to the amount of 1°·6, and in September to 0 ·09.

The fall of rain in July was 2·8 in., in August 3·7 in., and in September 3·1 in.; amounting in the three months to 9·6 in., and being 2·1 in. in excess. The fall of rain from January 1 is 25·1 in., being 6·9 in. in excess.

The mean temperature of the air at Greenwich for the three months ending August, constituting the three summer months, was 56°·7, being 3°·4 below the average of the preceding 89 years.

The Weather during the Quarter ending September 30, 1860.

1860. Months.	Temperature of Air. Mean.	Air. Diff. from average of 89 years.	Air. Diff. from average of 19 years.	Evaporation. Mean.	Evaporation. Diff. from average of 19 years.	Dew Point. Mean.	Dew Point. Diff. from average of 19 years.	Air—Daily Range. Mean.	Air—Daily Range. Diff. from average of 19 years.	Elastic Force of Vapour. Mean.	Elastic Force of Vapour. Diff. from average of 19 years.	Weight of Vapour in a Cubic Foot of Air. Mean.	Weight of Vapour in a Cubic Foot of Air. Diff. from average of 19 years.
	°	°	°	°	°	°	°	°	°	in.	in.	grs.	gr.
July	57·6	-3·8	-4·3	54·8	-2·9	52·3	-1·6	19·1	-1·6	·393	-·025	4·4	-0·2
August ..	57·7	-3·0	-3·8	55·0	-2·6	52·5	-1·6	15·4	-4·2	·396	-·027	4·4	-0·3
September	53·4	-3·0	-3·7	51·8	-2·2	50·2	-0·9	17·6	-1·0	·364	-·019	4·1	-0·1
Mean ..	56·2	-3·3	-3·9	53·9	-2·6	51·7	-1·4	17·4	-2·3	·384	-·024	4·3	-0·2

1860. Months.	Degree of Humidity. Mean.	Degree of Humidity. Diff from average of 19 years.	Reading of Barometer. Mean.	Reading of Barometer. Diff. from average of 19 years.	Weight of a Cubic Foot of Air. Mean.	Weight of a Cubic Foot of Air. Diff. from average of 19 years.	Rain. Amount.	Rain. Diff. from average of 45 years.	Temperature of Water of the Thames.	Reading of Thermometer on Grass. Number of Nights it was At or below 30°.	Number of Nights it was Between 30° and 40°.	Number of Nights it was Above 40°.	Lowest Reading at Night.	Highest Reading at Night.
			in.	in.	grs.	grs.	in.	in.	°				°	°
July	83	+7	29·845	+0·043	534	+7	2·8	+0·1	62·6	0	9	22	32·0	51·7
August ..	83	+6	29·556	-0·244	528	0	3·7	+1·3	60·9	0	6	25	37·0	55·0
September	88	+7	29·761	-0·071	537	+3	3·1	+0·7	58·4	1	16	13	28·0	53·0
Mean ..	85	+7	29·721	-0·091	533	+3	Sum 9·6	Sum +2·1	Mean 60·6	Sum 1	Sum 31	Sum 60	Lowest 28·0	Highest 55·0

Note.—In reading this table it will be borne in mind that the sign (–) minus signifies below the average, and that the sign (+) plus signifies above the average.

ON

THE METEOROLOGY OF ENGLAND

DURING

THE QUARTER ENDING DECEMBER 31, 1860.

BY JAMES GLAISHER, ESQ., F.R.S.,

SEC. OF THE BRITISH METEOROLOGICAL SOCIETY.

WITH the exception of the last ten days in October, and the first ten days in December, the weather has been cold throughout the quarter. The deficiency of temperature was large about the 12th of October, was about 3° below the daily average in November, and was very large from the 18th to the 29th of December, the cold having been singularly severe between these days, exhibiting a great contrast to the weather at the beginning of the month. On December 5th and 6th the excess of temperature above the average was 9°; from the 18th to the 23rd it was each day from 7° to 10° below; as much as 15° on the 24th; 16° on the 25th; and 14° on the 29th. On the 7th day the temperature in the neighbourhood was as high as 54°, and on the 25th and 29th was as low as 7° and 8°. These latter temperatures are very remarkable for December. In the year 1846 the mean temperature of December was 32°·9, being 3°·4 lower than in the month just passed. In the year 1852 it was 47°·6, or 11°·3 warmer than in 1860. This was the hottest December in the last 20 years.

The mean temperature of October was 1° above, of November was $2\frac{3}{4}$° below, and of December was 4° below their averages as found from the observations of the preceding 19 years.

The pressure of the atmosphere was slightly above its average in October, and below in November and December, being smaller in December than in any December for 20 years.

The fall of rain was slightly deficient in the quarter, and amounted to 32 in. in the year. This was exceeded in the years 1821, 1824, and 1852; but is greater than in all other years since the year 1815.

The mean temperature of the air at Greenwich for the three months ending November, constituting the three autumn months, was 48°·3, being 1°·1 below the average of the preceding 89 years.

THE WEATHER DURING THE QUARTER ENDING DECEMBER 31, 1860.

1860. MONTHS.	Temperature of Air. Mean.	Air. Diff. from average of 89 years.	Air. Diff. from average of 19 years.	Evaporation. Mean.	Evaporation. Diff. from average of 19 years.	Dew Point. Mean.	Dew Point. Diff. from average of 19 years.	Air—Daily Range. Mean.	Air—Daily Range. Diff. from average of 19 years.	Elastic Force of Vapour. Mean.	Elastic Force of Vapour. Diff. from average of 19 years.	Weight of Vapour in a Cubic Foot of Air. Mean.	Weight of Vapour in a Cubic Foot of Air. Diff. from average of 19 years.
	°	°	°	°	°	°	°	°	°	in.	in.	grs.	gr.
October ..	50·6	+1·2	+0·9	49·1	−0·9	47·6	+1·7	14·1	−0·5	·330	+·019	3·7	+0·2
November	40·8	−1·6	−2·7	39·9	−2·0	38·9	−1·3	11·4	−0·2	·237	−·019	2·7	−0·2
December	36·3	−2·7	−4·0	35·2	−3·6	33·5	−3·6	8·6	−0·9	·192	−·035	2·2	−0·4
Mean ..	42·6	−1·0	−1·9	41·4	−1·6	40·0	−1·1	11·4	−0·5	·253	−·012	2·9	−0·1

1860. MONTHS.	Degree of Humidity. Mean.	Degree of Humidity. Diff. from average of 19 years.	Reading of Barometer. Mean.	Reading of Barometer. Diff. from average of 19 years.	Weight of a Cubic Foot of Air. Mean.	Weight of a Cubic Foot of Air. Diff. from average of 19 years.	Rain. Amount.	Rain. Diff. from average of 45 years.	Temperature of Water of the Thames.	Reading of Thermometer on Grass. Number of Nights it was At or below 30°.	Number of Nights it was Between 30° and 40°.	Number of Nights it was Above 40°.	Lowest Reading at Night.	Highest Reading at Night.
			in.	in.	grs.	grs.	in.	in.	°				°	°
October ..	89	+2	29·856	+0·174	541	+2	1·6	−1·2	51·6	3	15	13	27·0	50·7
November	93	+4	29·696	−0·064	550	+3	2·5	+0·1	46·1	16	12	2	21·4	42·0
December	92	+3	29·491	−0·330	551	−1	2·8	+0·9	39·6	19	10	2	2·0	43·0
Mean ..	91	+3	29·681	−0·073	547	+1	Sum 6·9	Sum −0·2	Mean 45·8	Sum 38	Sum 37	Sum 17	Lowest 2·0	Highest 50·7

NOTE.—In reading this table it will be borne in mind that the sign (−) minus signifies below the average, and that the sign (+) plus signifies above the average.

STATE OF THE PUBLIC HEALTH.

1*st Quarter.*—The excess of births over the deaths in the quarter was 77,639; so the natural increase of the population of England and Wales was at the rate of 844 daily; and if the rest of the population increased equally fast, the natural increase of the United Kingdom must have been at the rate of 1266 daily. The increase exceeds any on record. 86,423 deaths were registered in the three months ending in September, or less by 17,916 than the deaths (104,339) registered in the corresponding quarter of last year. To every six deaths in the last there were only five in the present summer. The rate of mortality was 17; whereas the average of the season is 20 per 1000. The reduction of the mortality is observable in the town and in the country districts; but it is by far the greatest in the town districts. The average number of deaths in the town districts during the summers of 1850–9 was 52,861; whereas the deaths in the last summer were 45,495: in the country districts during the same periods the deaths were 43,697 and 40,928. The rate of mortality in the town districts fell from 23·75 to 18·42 per 1000; in the country and small town districts from 17·59 to 15·87, or 5·33 degrees in the town and 1·72 in the country districts.

2*nd Quarter.*—The births exceeded the deaths in the quarter by 59,691, and that was the natural increase of the population. In the year the natural increase of England and Wales was 260,930 souls—713 daily. If Scotland and Ireland increased at the same rate, the natural increase of the population of the United Kingdom must have been at the rate of 1069 daily. 102,557 deaths were registered in the last quarter of the year 1860, and the annual rate of mortality during the season was 2·024. The mortality was 0·158 below the average. Upon making up the account for the year, the deaths are found to be 422,500; and the annual rate of mortality 2·113; or a little more than 21 in 1000. The average of the preceding ten years is 22: so one life in every 1000 living was saved. Yet the mortality of England and Wales is still greatly in excess of the rate experienced in the least unhealthy districts. The deaths, instead of 102,557 would at that rate have been 79,283; so during the 92 days 23,274 persons died unnatural deaths in the least unhealthy country in Europe. The densest districts are still the unhealthiest. In the town districts the mortality was at the rate of 23 in 1000; in the country districts 18 in 1000. It is gratifying to find that the mortality of the town districts has declined from 25 to 23, and of the country districts from 19 to 18.

PRICE OF PROVISIONS.

1st Quarter.—The prices of provisions have been high during the thirteen weeks. Taking the corresponding weeks of 1859 as the starting point, the price of wheat rose 34 per cent., beef 7 per cent., mutton 11 per cent., potatoes 59 per cent. The average prices during the thirteen weeks were: wheat 52*s.* 1*d.* a quarter, beef $5\frac{5}{8}d.$, mutton $6\frac{3}{8}d.$ a pound by the carcase in the Leadenhall and Newgate Markets; York Regent potatoes 135*s.* a ton at Waterside Market, Southwark. The prices of the lower qualities of beef were stationary ($4\frac{1}{4}d.$), and the prices of the higher qualities rose from $6\frac{1}{4}d.$ to 7*d.* a pound. The prices of the lower and higher qualities of mutton rose $\frac{1}{2}d.$ and $\frac{3}{4}d.$ in the pound in the twelvemonth, and were respectively $5\frac{1}{4}d.$ and $7\frac{1}{2}d.$ a pound during the thirteen weeks.

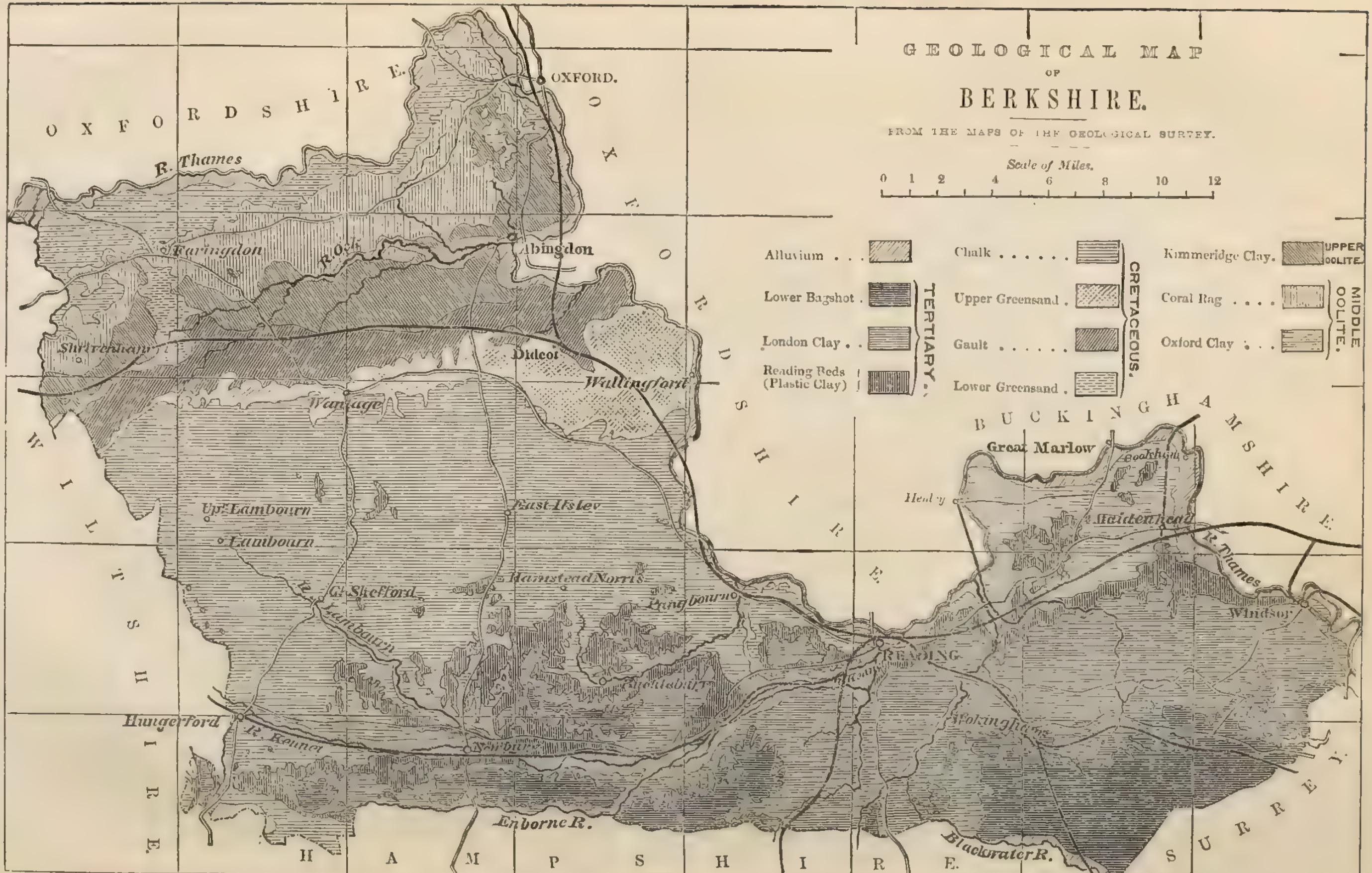
2nd Quarter.—Wheat was 56*s.* 9*d.* a quarter, or 31 per cent. higher in price than it was in the corresponding quarter of 1859. Beef at the Leadenhall and Newgate Markets was sold, by the carcase, at $4\frac{7}{8}d.$ a pound, or nearly $\frac{1}{2}d.$ less. Mutton was, on an average, $5\frac{2}{4}d.$ a pound, and remained the same as in the last months of 1859. The potato crop partially failed, and York Regents, at the Waterside Market, were sold at 122*s.* 6*d.* a ton, or at the rate of $1\frac{1}{2}$ lb. for a penny. The price of this universal article of food rose progressively in the last three months of the three years 1858–59–60 from 87*s.* 6*d.* to 102*s.* 6*d.* and 122*s.* 6*d.* a ton. To supply its deficiency other anti-scorbutic vegetables, fruit, or herbs are required.

THE PRICE OF PROVISIONS.

The AVERAGE PRICES of Consols, of Wheat, Meat, and Potatoes; also the AVERAGE QUANTITY of Wheat sold and imported weekly, in each of the Nine Quarters ending December 31st, 1860.

Quarters ending	Average Price of Consols (for Money).	Average Price of Wheat per Quarter in England and Wales.		Wheat sold in the 290 Cities and Towns in England and Wales making Returns.*	Wheat and Wheat Flour entered for Home Consumption at Chief Ports of Great Britain.*	Average Prices of Meat per lb. at Leadenhall and Newgate Markets (by the Carcase).		Average Prices of Potatoes (York Regents) per Ton at Waterside Market, Southwark.
				Average number of Quarters weekly.		Beef.	Mutton.	
1858	£.	s.	d.					
Dec. 31	$98\frac{1}{4}$	41	9	110,437	54,413	4*d.*—$6\frac{1}{2}$*d.* Mean $5\frac{1}{4}$*d.*	$4\frac{1}{4}$*d.*—$6\frac{3}{4}$*d.* Mean $5\frac{1}{2}$*d.*	80*s.*—95*s.* Mean 87*s.* 6*d.*
1859								
Mar. 31	$95\frac{5}{8}$	40	8	103,637	46,139	$4\frac{3}{4}$*d.*—$6\frac{3}{4}$*d.* Mean $5\frac{3}{4}$*d.*	$4\frac{3}{4}$*d.*—7*d.* Mean $5\frac{7}{8}$*d.*	80*s.*—100*s.* Mean 90*s.*
June 30	$92\frac{7}{8}$	47	3	96,514	99,533	$4\frac{3}{4}$*d.*—$6\frac{1}{2}$*d.* Mean 5[illegible]*d.*	5*d.*—7*d.* Mean 6*d.*	85*s.*—110*s.* Mean 97*s.* 6*d.*
Sept. 30	$95\frac{3}{8}$	44	0	85,707	50,291	$4\frac{1}{4}$*d.*—$6\frac{1}{4}$*d.* Mean $5\frac{1}{4}$*d.*	$4\frac{3}{4}$*d.*—$6\frac{3}{4}$*d.* Mean $5\frac{3}{4}$*d.*	65*s.*—105*s.* Mean 85*s.*
Dec. 31	$96\frac{1}{8}$	43	4	127,361	44,911	4*d.*—$6\frac{1}{2}$*d.* Mean $5\frac{1}{4}$*d.*	$4\frac{3}{4}$*d.*—$6\frac{3}{4}$*d.* Mean $5\frac{3}{4}$*d.*	85*s.*—120*s.* Mean 102*s.* 6*d.*
1860								
Mar. 31	$94\frac{5}{8}$	44	5	114,218	22,300	$3\frac{3}{4}$*d.*—$6\frac{1}{2}$*d.* Mean $5\frac{1}{8}$*d.*	$4\frac{3}{4}$*d.*—$6\frac{3}{4}$*d.* Mean $5\frac{3}{4}$*d.*	115*s.*—145*s.* Mean 130*s.*
June 30	$94\frac{7}{8}$	52	8	101,106	62,272	$4\frac{3}{4}$*d.*—$6\frac{3}{4}$*d.* Mean $5\frac{3}{4}$*d.*	$5\frac{1}{2}$*d.*—$7\frac{1}{2}$*d.* Mean $6\frac{1}{2}$*d.*	125*s.*—160*s.* Mean 142*s.* 6*d.*
Sept. 30	$93\frac{1}{4}$	59	1	66,539	139,142	$4\frac{1}{4}$*d.*—7*d.* Mean $5\frac{5}{8}$*d.*	$5\frac{1}{4}$*d.*—$7\frac{1}{2}$*d.* Mean $6\frac{3}{8}$*d.*	125*s.*—145*s.* Mean 135*s.*
Dec. 31	$93\frac{1}{4}$	56	9	73,770	197,396	$3\frac{1}{2}$*d.*—$6\frac{1}{4}$*d.* Mean $4\frac{7}{8}$*d.*	$4\frac{3}{4}$*d.*—$6\frac{3}{4}$*d.* Mean $5\frac{3}{4}$*d.*	115*s.*—130*s.* Mean 122*s.* 6*d.*
Col.	1	2		3	4	5	6	7

* NOTE.—The total number of quarters of wheat sold in England and Wales for the 13 weeks ending December 31st, 1858, was 1,435,678; for the 13 weeks ending March 31st, 1859, 1,347,277; for the 13 weeks ending June 30th, 1859, 1,254,682; for the 13 weeks ending September 30th, 1859, 1,114,191; for the quarter ending December 31st, 1859 (14 weeks), 1,783,050; for the 13 weeks ending March 31st, 1860, 1,484,837; for the 13 weeks ending June 30th, 1860, 1,314,386; for the 13 weeks ending September 30th, 1860, 865,007; and for the 13 weeks ending December 31st, 1860, 959,006. The total number of quarters entered for Home Consumption was respectively, 707,367; 599,807; 1,293,925; 653,789; 583,848; 289,906; 809,535; 1,808,848; and 2,566,145.



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JOURNAL

OF THE

ROYAL AGRICULTURAL SOCIETY OF ENGLAND.

I.—*On the Agriculture of Berkshire.* By J. B. Spearing.

Prize Essay.

Introduction.

Being a practical tenant-farmer connected with the county of Berks by a residence, first of ten years on the western border of the county, on a farm of 600 acres, and then by one of ten more years on the eastern side, on a farm of 800 acres, I have had ample opportunity of becoming acquainted with its soil, its farming, and its people: this has induced me to attempt writing the subjoined Report, trusting that any defect in style or composition may be dealt with leniently.

Berkshire, from its small extent, is not classed among the first of our English counties; but from the fertility of much of its soil, the progressive spirit of its agriculturists, and its various improved modes of farming, it is entitled to a very prominent position; and moreover acquires additional interest from the fact that, on its eastern boundary, stands the castle-residence of our Queen and the Prince Consort: and it is a subject of congratulation to the farmers of England that his Royal Highness has bestowed on agriculture a full share of that time and attention which he has so successfully devoted to the peaceful arts and sciences. All who take an interest in agriculture have seen or heard of the Shaw Farm and Royal Dairy with their magnificent buildings, and of the Flemish Farm and Norfolk Farm in Windsor Great Park, and have either witnessed or read of the many useful experiments and trials of implements carried on there; they have also seen many specimens of the different breeds of stock from the Royal Farms at the annual shows of the Royal Agricultural Society, the Smithfield Club, and the Birmingham Cattle Show, at each of which his Royal Highness has frequently been a successful competitor. The Royal Farms might of themselves afford sufficient materials for a voluminous report, far exceeding the limits which can be assigned to them in this place; I shall content myself, therefore, with a brief account of them under the head of Characteristic Farms.

From the very able Report by Mavor, in 1809, it will be seen that the farming of Berkshire at that time was much more fully developed than that of many other counties, and that everything was not left for this generation to do; but when we compare its present state with the past, we find that many very extensive improvements have taken place, and these for the most part within the last twenty years: indeed we may safely say that the whole system of farming since the date of that Report has been revolutionized, and what was then considered very far advanced would now be thought extremely antiquated. The talented author points out many of the obstacles which then stood in the way of improvement, the greater part of which are removed at the present day: among the most prominent was the want of enclosures, for much of the arable land at that period was in open or common fields; the whole has since been enclosed, with one exception, viz. Charlton, a hamlet in the parish of Wantage, where I am told, by a resident in the immediate neighbourhood, that the land would be increased thirty per cent. in value if enclosed. The system of taking tithes in kind is stated as another grand obstacle to agricultural improvement, one which the Tithe Commutation Act has removed for ever. The want of leases is said to be another drawback, although it appears from the author's statement that they had been more generally granted in Berkshire than in many other parts of England, for he says, "the progress which agriculture has made in the county above some others may in a great measure be ascribed to that permanent security which a numerous and respectable yeomanry have in their possession. That security is the very soul of improvement; and even unlimited capital in the hands of a prudent man will never be partially risked without the fair prospect of a return, not depending on the will of others, but on his own judgment and industry." There is no longer any reason why the want of leases should check improvement, there being but few landlords who will not grant them on equitable terms to enterprising and respectable tenants. Poor-rates are spoken of as another and an increasing burden, varying, in 1809, from five to eight shillings in the pound, and in some cases rising even higher. The New Poor-Law Act of 1834 has placed the poor in a very different position; and while it has made them more self-reliant and independent, has lessened the burden of poor-rates, which do not now exceed 2*s.* 4*d.* in the pound in some parts of the county and 3*s.* in others; the average of the whole county being 2*s.* 10½*d.* in the pound.

I shall have occasion to refer to this Report elsewhere, and have only done so here to show, not so much the improvements that have taken place, as the facilities afforded for such improve-

ments. I will not, however, pass on further without congratulating my brother-farmers that one recommendation in that Report has never been adopted: I refer to the preservation and encouragement of the growth of timber. The author, after lamenting that the quantity of timber was most perceptibly diminishing in our island; that every kind was nearly doubled in price; and that no sooner did a young man come into the possession of his estate than he frequently began to strip it of its timber in order to discharge the debts he had often wantonly contracted, suggests, that when neither the interest of descendants nor the public welfare have any effect on the conduct of proprietors of woodlands, it is time that the control should be delegated to other hands, and that the sanction and enactment of laws should be called in as auxiliaries to effect what a sense of duty fails to accomplish. "A law therefore," he says, "to restrain proprietors from cutting down trees not arrived at perfection, and to compel them to plant two in a suitable situation in the room of each one felled would neither be arbitrary nor unjust." I need hardly say that fifty years ago such opinions may have been held with some degree of reason. Since steam-power has brought to our shores the produce of the immense forests of Canada and the north, which is superior in quality to our own for most purposes, at a cost which has greatly lowered the price of timber; and since iron has been largely used for ship-building, we need hardly be apprehensive of that want which he so much dreaded. All practical men are pretty well agreed that timber and corn cannot be grown together to advantage; that hedgerows are a great bar to agricultural improvement; the British farmer, therefore, invariably rejoices when the axe is put to work.

Statistics of Population, Area, Rates, and County Expenses.

Berkshire is an inland county of very irregular form, extending from 51° 19′ to 51° 48′ N. lat., and from 34′ 30″ to 1° 43′ W. long.; its extreme length is 48 miles, greatest breadth 29 miles, and circumference 208 miles; it comprehends an area of 734 square miles; and, according to the population returns of 1851, 451,040 acres, or, according to the assessments to county-rate, 450,358 acres. There are various accounts of the area of the county, but I believe the above to be the most correct. The 'Parliamentary Gazetteer' says that it comprehends an area of 752 square miles, and consequently 481,280 acres, or, according to the population returns of 1831, 472,270 acres; these figures are evidently taken from Arrowsmith's great map of England; and as there are many insulated parts in the county, in the neigh-

bourhood of Wokingham and Twyford, belonging to Wiltshire, I have no doubt they are included.

Mavor, in his Report to the Board of Agriculture, gives three different accounts of the area of Berkshire—one taken from the Trigonometrical Survey, by Government, which, including its insulated parts, computes it at 464,500 acres; another, taken from the Report published by order of the House of Lords in 1805, which states the area to be 744 square miles, equal to 476,160 acres; and a third, taken from Rocque's Map of Berkshire, published in 1761, which gives 438,977 acres.

Berkshire is divided into twenty hundreds, viz., Hormer, Ock, Ganfield, Faringdon, Shrivenham, Wantage, Kintbury Eagle, Lambourne, Faircross, Moreton, Reading, Compton, Charlton, Theale, Sonning, Wargrave, Baynhurst, Cookham, Bray, and Ripplesmere; contains four boroughs, viz., Reading, Wallingford, Windsor, and Abingdon; twelve market-towns, viz., Abingdon, Reading, Newbury, Windsor, Wallingford, Maidenhead, Wokingham, Faringdon, Hungerford, East Ilsley, Wantage, and Lambourne. There are twelve unions in the county, containing 234 parishes (of which about one-third are in Oxfordshire, Hampshire, and Wiltshire), viz., Abingdon, 38 parishes; Bradfield, 29; Cookham, 7; Easthampstead, 5; Faringdon, 31; Hungerford, 20; Newbury, 18; Reading, 3; Wallingford, 28; Wantage, 33; Windsor, 6; and Wokingham, 16. The annual value, as assessed to the county-rate, is 681,201*l.* Cost of police-force for the year 1859, at 2½*d.* in the pound, was 7095*l.* 16*s.* 10½*d.*; and other county expenses, at 3¾*d.* in the pound, 10,643*l.* 15*s.* 3¾*d.*

The population of Berkshire, according to the returns in 1841, was 161,759; and in 1851, 170,065, of which 84,927 were males and 85,138 females, being an increase of five per cent. in the ten years.

The following is an account of the Poor-rates, *not including* those parishes which are attached to the unions but belong to other counties:—

	Amount Raised from Poor-Rates.	Amount Expended for Relief to Poor.	Amount Expended for all purposes.
	£.	£.	£.
For year ending Ladyday, 1857	101,226	77,805	101,849
,, ,, 1858	95,048	74,888	101,669

Physical Features and Rivers.

Berkshire is bounded on the north, for a distance of nearly 105 miles, by the river Thames, which separates it from the counties of Gloucester, Oxford, and Buckingham; on the east

by Surrey; on the south by Hampshire; and west by Wiltshire. The climate is most healthy, and varies with its altitude and aspect: some elevated portions of the chalk-hills are bleak and cold; the valleys, on the other hand, are very mild and salubrious. The most elevated portions are a series of downs, a continuation of those on the northern part of Wilts; they reach an altitude of 893 feet near the White Horse Hill, and terminate very abruptly near Streatley, causing the bold and beautiful scenery for which that neighbourhood is celebrated. Here it seems as if by some extraordinary convulsion of nature a passage had been made for the Thames through the chain of hills which pass from Berkshire into Oxfordshire, and extend on through Buckingham.

The latitudinal position of Berkshire places it among the most forward counties in England in respect of temperature.

The amount of rain-fall, as registered at Whitewortham, in this county, for the year 1859 was 27·65 in.

The following meteorological account for the year ending Michaelmas, 1859, was taken at Oxford, on the northern, and Aldershot on the southern, boundary of the county:—

OXFORD.					ALDERSHOT.				
Months.	Temperature.			Rain.	Months.	Temperature.			Rain.
From Oct. 1, 1858, to Oct. 1, 1859.	Highest.	Lowest.	Mean.	Inches.	From Oct., 1858 to Oct., 1859.	Highest.	Lowest.	Mean.	Inches.
1858					1858				
October ..	66·9	31·0	50·2	2·0	October	69·5	30·0	50·9	1·5
November	54·8	15·4	39·1	0·8	November	55·5	19·0	39·0	0·6
December	53·2	28·0	40·2	2·0	December	52·0	25·0	40·8	1·8
1859					1859				
January ..	53·5	28·0	40·5	0·8	January	51·5	27·0	43·2	1·0
February	56·0	29·5	42·9	1·7	February	56·5	30·0	43·9	1·5
March ..	64·0	22·0	45·6	1·5	March ..	68·0	26·0	46·6	1·5
April ..	74·5	27·0	45·0	2·5	April ..	80·0	26·0	48·6	2·8
May	72·0	37·0	52·3	1·7	May ..	78·4	32·5	51·6	2·2
June.. ..	77·0	42·5	60·5	2·2	June ..	82·5	41·5	61·2	2·4
July ..	86·0	51·0	65·1	2·8	July ..	93·0	44·0	67·5	1·6
August ..	81·0	47·0	61·4	3·8	August ..	87·3	46·5	63·5	2·2
September	71·5	39·0	55·4	3·5	September	76·7	40·5	56·4	5·0
Total ..	..	..	..	25·3	Total ..	..	..	..	24·1

The average depth of rain in Berkshire for a series of years is 22·199 in.; consequently we might infer from the Tables that the year ending Michaelmas, 1859, was more than usually wet, yet so far as agriculture is concerned, exactly the contrary was the case; for a season cannot, in an agricultural point of view, be

called a wet one simply because a large amount of rain has fallen, nor a dry one because the rain-fall has been small; for, although the land received four inches in one day, it may still have been on the whole in a dry state if this ran off quickly and did not saturate the soil. It will be seen that by far the greater portion of the rain which fell in this year fell during the six months in which the temperature was highest, and the power of evaporation great; whereas a very small amount fell during the six months in which the temperature was lowest and the power of evaporation small.

I have chosen to give the meteorological account from Michaelmas to Michaelmas, considering it most useful for all agricultural purposes, as it satisfactorily explains why, during the last summer, greater distress for want of water was experienced on the hills and dry parts of the county than for many years past. If there is a small amount of rain during the autumn and winter quarters, when alone it saturates the soil and raises the springs, no ordinary amount in the spring and summer quarters can have that effect; consequently it may safely be inferred that a winter deficient in rain-fall will in most cases be followed by a summer in which a want of water will be materially felt: I name this as such seasons much affect agricultural progress. The increased application of steam power to agriculture gives additional importance to the question of the supply of water in dry seasons, by the construction of tanks and ponds in high situations. Instances are not wanting where the cost of drawing water to supply the steam-engine when threshing, has been equal to one-half of the whole cost of threshing by horse-power.

Rivers.—The principal river of Berkshire is the Thames: it enters the county at St. John's Bridge, one mile south of Lechlade, in Gloucestershire, and passes the towns of Abingdon, Wallingford, Reading, Henley, Maidenhead, and Windsor. The Kennet enters the county from Wiltshire, near Hungerford, passes Kintbury and Newbury, and falls into the Thames near Reading, running 25 miles in Berkshire. The Lambourne rises in the chalk-hills near that town, passes Eastbury, Eastgarston, Great and Little Shefford, Weston, Welford, Easton, Boxford, Bagnor and Donnington, and falls into the Kennet, near Newbury, running about 14 miles. The Loddon rises near Aldershot, Hants, enters Berkshire at Swallowfield, passes Loddon Bridge and Twyford, and falls into the Thames near Wargrave, running 12 miles in Berkshire. The Ock rises near Uffington, in the Vale of White Horse, passes Wantage, and falls into the Thames at Abingdon, running about 20 miles. There are two lines of canal in the county. The Wilts and Berks extends from the Thames near Abingdon through the Vale of

White Horse to the western border (entering Wiltshire beyond Shrivenham) and joins the Kennet and Avon Canal at Seamington, near Melksham, being 52 miles long. The Kennet and Avon Canal starts from the Kennet above Newbury, and enters Wiltshire a little below Hungerford.

Geological Features and Agricultural Description.

Berkshire is a purely agricultural county, having no mineral productions. Its geological features embrace the Bagshot sand, London and Plastic Clay, the Chalk, the Greensand and the Gault; the Kimmeridge Clay, the Coral-rag and Oxford Clay, included within the Cainozoic or Tertiary, and the Mesozoic or Secondary systems, as classified by geologists. Although there are many varieties of soil, yet, for the present purpose, it is not necessary to make more than three agricultural divisions.

1*st Division.*—The Bagshot Sand, and strong loamy soils of the London and Plastic Clay formation, as shown on the accompanying map.

2nd Division.—The Chalk, numbered 3.

3rd Division.—The Vale, numbered 4, 5, 6, 7 and 8.

The 1*st Division*, commencing at the extreme east of the county, includes the whole of Windsor Park; it forms a very irregular junction with the Chalk, first taking a direction towards Twyford, thence to the south of Reading, and occupying a narrow strip on the whole south side of the county. In rising the Runnymead, between Staines and Windsor, we meet with the Bagshot Sand, which occupies the upper surface; it includes a portion of Windsor Park on the south, and extends to Ascot Heath and nearly to Wokingham, and thence to Swallowfield on the south side of the county: this sand, however, is shown principally on the other side of the Blackwater River in the adjoining county of Hants. Extensive heaths and plantations of fir-trees form the principal feature of this surface, but the valleys, where admixed with vegetable matter, afford a light tillage, whilst a slight deposit of gravel is found in some places on the sand, as seen on the Norfolk Farm in Windsor Great Park. The subjoined account of what has been done by R. Gibson, Esq., of Sandhurst Lodge, shows the extent to which this heath-land is capable of being improved; so that a soil which formerly only produced firewood is now worth to rent at least 1*l.* per acre. The land was first well trenched, to the depth of from 2 to 3 feet, so as to break through the iron rust which generally prevails in that locality; about 3 waggon-loads of chalk were then applied to the acre, and, where the land was light, a coating of clay or loam. In some places draining was required to the depth of 3 feet. The first crop taken was rape or turnips, with the appli-

cation of good yard-manure. This land has grown Swedes averaging 20 tons per acre, and this year considerably more, in only the fourth year of its cultivation. It has also grown good clover, oats, and rye, and this year exhibits some promising wheat; the first crop is produced at a cost of 20*l.* per acre, which time is likely to repay. In the neighbourhood of Wokingham, where there is a good depth of soil before coming to the clay, the land is grateful and productive, but the light sands burn quickly, and in wet seasons the corn becomes yellow and does not yield well; this land seems calculated for the production of wheat and oats with advantage to the grower. A considerable breadth of beans is planted, but the soil is not strong enough to be called good bean land. The red or broad clover grows well; barley is bad in quality and yields hardly more than half as much produce as oats: with proper management all descriptions of root-crops may be successfully grown. The land requires to be kept in good condition by constant cleaning, being subject to a running grassy kind of couch, as is often the case on a light soil with a wet subsoil. The larger holdings in the district have within the last nine years been much improved, both by laying small fields into large ones and by draining, which has been attended with great success; many holdings, however, are still small and badly cultivated, in some instances from want of judgment, in others from lack of sufficient capital, and in not a few cases from these two wants combined.

The grass-land, in general, produces little and that of middling quality, although some of it is very useful, but it is not good stock-land, in consequence of its cold subsoil.

The London Clay (on which the Bagshot Sand rests) is indicated by a heavy tillage and by brick-yards at the boundary of the sand and clay. It commences at Old Windsor and extends to the parish of Winkfield, forming as irregular a junction with the Plastic Clay as that does with the Chalk; this London Clay is again shown at Wokingham, also near Reading, and on the south side of the Kennet, more or less occupying the cap of the hills to the edge of the county: beneath this London Clay crops out the admixed soil, the sand and clay of the Plastic Clay formation with varied depths of sandy flint-gravel, as shown in the neighbourhood of Reading; it constitutes a happy mixed soil, having an ample supply of calcareous matter abraded from the chalk, the next stratum below. These clay-soils are mostly characterized by small enclosures and the growth of the oak and the elm.

The heavy land in this district grows good wheat, beans, and oats, and, when drained, heavy crops of roots. There is also a light sandy loam, on a yellow sand subsoil, near Bagshot

Heath, which is very suitable for any kind of crop except beans, and yields exceedingly well; but when the subsoil is gravel instead of sand, the land is equally noted as being bad and unprofitable. The rent, including tithes, is from 26*s.* to 36*s.* per acre. White wheat is grown, yielding about 4½ qrs. per acre; Tartar oats, 10 qrs.; barley, 5 qrs.; beans, 4 qrs. Most of the land is drained in this district on the system to be described under that head. The size of the farms is from 100 to 400 acres.

On the south of the Great Western Railway, between Theale and Newbury, in the parishes of Aldermaston, Brimpton, Crookam and Thatcham, there is a considerable deposit of gravel, in some cases sufficiently deep to obliterate the broad geological features of the soil, in which case its agricultural character becomes very similar to that of the valley of the Kennet below Newbury.

Mavor includes the greater part of this division in the Forest district; he speaks of the sand as almost unsusceptible of cultivation, and of the strong clay-soil as much wanting draining, which alone he considers essential for its improvement and the full development of its productive powers; he makes an exception, however, in favour of His Majesty's farms in Windsor Great Park, where, he says, draining had been carried on with a royal spirit and with the greatest success. Much of this district at that period was unenclosed; the improvement which has taken place in it since the date of that Report is greater than in any other part of the county. Windsor Forest at that time included the parishes of Old Windsor, New Windsor, Winkfield, Sunninghill, Binfield, Easthampstead, Sandhurst, Finchampstead, Barkham, Wokingham, Arborfield and Swallowfield, and parts of Clewer, Bray and Hurst, the unenclosed portions of which amounted to about 24,000 acres; these were enclosed by Act of Parliament in 1813. The lands requiring it have been drained on the best and most approved plan, the sands much cultivated, and in many instances made to produce luxuriant crops of roots and corn.

2nd Division.—The Chalk.—This division occupies the whole centre of the county, and nearly one-half of its area. The sheep downs, which run up to the range of hills known as the Ridgeway or White-Horse Hill, form its northern boundary: this range of hills enters Berkshire, near Ashbury, and terminates at Streatley. The ground slopes gradually to the valley of the Kennet, where the Chalk forms a junction with the Plastic Clay; extending eastward, the hills run almost parallel with the Great Western Railway to Reading, Twyford, Maidenhead, and thence nearly to Windsor.

The nature of the soil in this division is extremely varied,

and requires lengthened description. The margin of the Thames (varying much in width) from Old Windsor to the Wallingford Road Station, on the Great Western Railway, is an alluvial soil, being an admixture of the London and Plastic Clay, Bagshot Sand, and flint-gravel, forming a rich gravelly loam. In this valley the land in many places is ploughed nearly to the edge of the river; where it lies low there is a considerable width of meadows which are subject to floods. Seldom can so great a diversity of soil be seen in so small a compass as that which lies between the Great Western Railway and the valley of the Thames from Maidenhead to Reading: here we have sharp gravels, good loams, and tenacious clays, with all the intermediate gradations; the chalk which underlies the whole approaches at some points close to the surface, whilst at others there is a varied depth of gravel. The presence of the chalk beneath the heavier lands is an important feature, affording, as it does, a simple drainage, with or without pipes, according to circumstances; in the stiffest clays they have only to bore through to the chalk, and all surface water is removed. There is a field in the parish of Cookham possessing a special interest; it consists of Thames deposit, and grows crops of corn of very great bulk, without any supply of manure.

The Kennet Valley has a mixed soil, composed of the sand and clay of the Plastic Clay formation, together with flint-gravel and much vegetable humus; in some instances a deep peat exists on the surface, as seen in the meadows between Kintbury and Newbury. The slopes of the valley formed by the river Lambourne, and by the stream which passes through Hampstead-Norris, Frilsham, Bucklebury, Bradfield, and Tidmarsh, as well as the bottoms themselves, are of a superior quality, composed generally of a rich gravelly loam. The other valleys, and most of the hills, are capped with a mixed soil of plastic clay and sand, and are fertile just in proportion to the quantity of sand mixed with the clay. The greater part of the parishes of East Garston, Fawley, Farnborough, Shefford, Welford, Chaddleworth, Wickham, Boxford, Leckhampstead, Brightwaltham, Peasemore, Catmore, and Beedon, are of this uniform description, and are very productive. The clay is not very tenacious, and, although very wet in rainy weather, soon transmits the water through to the chalk below, and is dry again; the clay, however, is sufficiently thick on the caps of some of the hills to justify geologists in classing them with the London and Plastic Clay of the first division, as shown on the map. This clay is used for making bricks at Beedon, Frilsham Common, and Upper Basildon, &c.

Where there is a deficiency of sand, as in Lambourne woodlands, the soil is cold and less fertile; nothing improves it so much

as chalking, which is generally done at a cost of 40*s.* to 42*s.* per acre, by sinking a shaft through the clay and drawing the chalk up by means of a wheel and basket, to be spread on the ground at the rate of 16 or 18 bushels to the pole, early in the autumn, before the frosts set in, which pulverise it and make it mix readily with the soil. About two years after land has been treated thus, it ploughs one horse lighter than it did before. Where this clay prevails, the enclosures for the most part are small, and bounded by trees; where either no sand is mixed with the clay, or where it is too deeply deposited on the clay, the soil is very poor and sterile.

The deep sand is shown on a strip of land commencing at Wickham Heath, in the parish of Welford, and running nearly to Newbury, and more or less so on some of the commons lying in the line between Newbury and Basildon: this description of soil is of little value for agricultural purposes, but grows good fir-trees where they have been planted, and a considerable quantity of heath and birch, which is used for making brooms. As we approach the old ploughed lands on the downs, the soil is composed of a thin hazel mould on rubbly chalk, and where the hills are very abrupt the chalk rises completely to the surface; but in the newly broken-up down-land there is a covering of black sandy vegetable mould, full of fibres, with an admixture in some places of flints. The latter is the most unproductive, but with continual ploughing, and bringing to the surface the rubbly chalk from below, the mould, modified by this admixture, gradually assumes the hazel colour of the older cultivated lands.

The large boulder or Sarsden stones, lying on the surface of the downs in many places, but more particularly at Ashdown Park, near Lambourne, are sandstones, the remains of stratification that is not to be seen, and are identical with the Grey Wethers of Wiltshire, constituting the Druidical temples at Stonehenge, Abury, &c.

This division, in addition to its fertile valleys, can boast of the best class of strong lands which, with good farming, will yield in favourable seasons most splendid crops. As a necessary consequence the variety of soil causes great variety in the value. The arable land lets at from 18*s.* to 45*s.* per acre, including tithes, as under :—

	s.		*s.*	
Valley of the Thames, from	35	to	45	per acre.
Valley of the Kennet, from	30	,,	35	,,
Other valleys, from	28	,,	35	,,
Strong loamy table-lands, from	25	,,	38	,,
Strong wet lands in Lambourne woodlands, from	18	,,	27	,,
Light chalk hills, from	18	,,	25	,,
Downs, from	7	,,	12	,,

Here the farms are large, ranging from 400 acres to 1000 acres, and are in some cases cultivated by their proprietors, but more frequently by an intelligent and influential body of tenant-farmers. They are, generally speaking, well adapted for the breeding of sheep, which are usually sold at the fortnightly markets or fairs held in the spring, summer, and autumn months, at East Ilsley, in the centre of this division, and are for the most part taken into the grazing districts: the ewes to produce early lambs for fattening, and the rest to be fed for the London market.

The valley of the Thames, part of the Kennet Valley towards Reading, and the other portion of this district on the south-east side, are suited for the growth of white wheat; the northern and western parts are celebrated for producing red wheat of good quality, the best samples of which always command a high price from the millers for mixing with the white wheats and giving strength to the flour. The barley grown on the gravelly soils and chalk hills is generally of a superior quality, and, in dry seasons like the last, the produce of the strong land is very good, but for the most part they are planted with oats, producing from 10 to 12 quarters per acre. Beans and peas are sometimes grown, but only to a small extent, being a very uncertain crop. Peas of an early sort are planted on the eastern side of the county, and are sold for gathering to supply the London markets, the land being immediately afterwards ploughed and sown with turnips. Under the present improved system of cultivation there is but little of this division that does not produce good crops of roots and artificial grasses.

3rd Division.—THE VALE.—Below the escarpment of the chalk, as we descend into the Vale, we come to the Upper Greensand and Gault; which runs east and west, and follows the line of the Lower Chalk, occupying a breadth of about 5 miles. The soil—a mixture of the lower chalk, marl, and greensand—is very rich, and fit for the production of every kind of crop; it may be classed with the best corn-producing lands in England, particularly in the four parishes of Challow, Wantage-cum-Charlton, Ardington, and Hendred, where much of the land is of easy tillage, and yet will carry wheat to a very great bulk without being laid. It is generally planted with two white crops in succession, or in some instances with wheat and beans in alternate years, and it continues to produce good crops under this management.

The beautiful sample of hops which is produced at Milton Hill, shows that the soil is peculiarly suited to the growth of that plant, but—as in character it much resembles that in the neighbourhood of Farnham in Kent—this fact requires no further comment, than that it is surprising that this crop is not cultivated

to a greater extent. This locality is celebrated for the very productive orchards with which it abounds; more particularly in the parishes of North and South Moreton, East and West Hagbourne, Blewbury, Upton, Harwell, and East and West Hendred. The apples, pears, damsons, and more particularly the cherries (although a very uncertain crop), are very remunerative to the occupier, who either sends them by rail to London at the wholesale price, or retails them out in the neighbourhood.

The annual value of this land varies from 35*s.* to 50*s.* per acre, including tithes.

As we approach the Thames we find gravels in some cases so mixed with the soil as to give it the character of a rich gravelly loam, and in others of such a depth as to bring it under the denomination of a sharp gravel. This description applies to portions of the parishes of Wallingford, Whittenham, Sutton, Drayton, Abingdon, and Radley. This is the most forward district in the county, and it not unfrequently happens that the wheat harvest is completed here before the corn is fit for the sickle on the south-western side.

As we quit the Gault and proceed northward, we meet with a narrow strip of the Lower Greensand. I will not venture to assign an agricultural character to it, as it is not sufficiently defined, and is to a certain extent replaced by the gault. Beyond it we find the Kimmeridge Clay, which, between Highworth, Faringdon, and Abingdon, forms a very irregular line with the Coral-rag which overlies the Oxford Clay, and extends to the river Isis or Thames, the northern boundary of the county. In traversing the space described as coral-rag till we reach the Oxford clay, we meet with various deposits of gravel and sand, the Kimmeridge clay occasionally breaking out: the soil is so diversified that a full description of it would fill a larger space than is desirable here.

The centre of this division is occupied by a considerable breadth of grass-land which I shall have occasion to refer to elsewhere. In the neighbourhood of Faringdon the surface-soil, viewed as farming land, is wonderfully varied; in one field may be seen burning gravel, limestone rock, and sand; in another stonebrash, with streaks of peaty vegetable mould and clay. Again, at Longworth, we find sand, loam, stonebrash, and clay, whilst in other parts there is much calcareous sand of light tillage. The whole district produces very excellent crops of roots and corn; its value, including tithes, is from 30*s.* to 35*s.* per acre. The soil being so various, the course of cropping is very irregular.

The benefit that has resulted to agriculture from the establishment of the Royal Agricultural Society is universally acknow-

ledged, but nothing has tended more to improve the cultivation of the soil than the publication of their Journal; through it the most improved modes of farming have been brought before the public, and the most practical experiments have been discussed and particularised, so that the English farmer of the present day is no longer left to hold the same opinions, and carry out the same system that his ancestors and neighbours have done, but has the benefit of the most practical and scientific information that the world can produce. Of these advantages I may safely say that the farmers of Berkshire have been by no means backward in availing themselves; in many cases to such an extent that to give an account in detail of many of the best systems of farming carried out in this county would be only to repeat what has already more than once appeared in the Journal. If therefore in the following account it should be thought that too little is said on some heads, I may state in explanation that I purposely avoid useless repetition, that I may be able to say more on those subjects which have hitherto received the least attention.

Tillage and Cropping.

Although some of the land in the county is very irregularly cropped, yet, from information I have obtained, I find that three systems very generally prevail, and that by far the greater portion is managed under one of them. That mostly in favour on the south and south-east of Reading is a 5-course:—

1st year, Roots.
2nd year, Barley or Oats.
3rd year, Grass.
4th year, Wheat.
5th year, Barley or Oats.

Some preferring the following:—

1st year, Roots.
2nd year, Oats.
3rd year, half Clover, half Beans or Peas.
4th year, Wheat.
5th year, Barley.

The former has the preference on the lands which are best calculated for sheep, the latter on the stronger soils which do not carry sheep so well. The course adopted generally in the centre of the county and on some of the gravels south-east of Reading is the common 4-course:—

1st year, Roots.
2nd year, Barley or Oats.
3rd year, part Grass, part Rape and Turnips, fed off for Wheat.
4th year, Wheat.

On the northern part of the county—

1st year, Roots.
2nd year, Barley or Oats.
3rd year, half Clover, half Beans.
4th year, Wheat.

Much of the strong land in the Vale is cultivated as seasons direct, but some adhere to one of the following rotations as nearly as circumstances allow:—

1st year, Wheat.	1st year, Wheat.
2nd year, Barley.	2nd year, Beans.
3rd year, Beans, a small portion Roots.	3rd year, Barley or Oats.
	4th year, Beans.

Roots.—The preparation for, and cultivation of, the root-crop forms one of the most important features in modern agriculture, and may now be said to commence before the preceding one is finally gathered. No sooner are the wheat-stubbles cleared, than the first opportunity is seized on by the farmer to put into operation the broadshare or skim-plough, and the sunny days of autumn are found to be the great assistants in cleansing the fallows for the succeeding turnip-crop. The wheat-sowing once got through on the farm, the fallows are ploughed, and in most instances experience has proved that if manure from the farm-yard is to be applied, its early application is desirable; the system of winter manuring being found not only to assist the crop by the thorough incorporation of the manure with the soil, but also much to facilitate the spring work on the farm. It is, therefore, now rather the exception than the rule to adhere to the old-fashioned wasteful method of carting out the manure from the yard during the spring months.

The cultivation of mangold has been much increased of late years in almost every root-growing parish: they best escape that pest of all root-crops in their early stages, the "fly;" and the last few mild winters have been so much in favour of their keeping, that many farmers have treated them in the same manner as their swedes, feeding them on the land with sheep without attempting to store them, and have found that, by commencing early enough in the season, the stomach of the sheep seems to get accustomed to the mangold, so that the injurious effects generally supposed to arise from early feeding are obviated. The present winter will, however, be a test how far the necessity of storing mangolds—essentially a spring food—must be recognised.

Mangold cultivation is now well understood by all farmers who have any pretensions to skill in growing roots. Clean land, deep-ploughing, copious dressings of good farmyard manure, with a liberal application of guano or superphosphate of lime, not forgetting 4 to 6 cwt. of salt per acre, are requisite to ensure

success. Some contend for the seed being dibbled by hand or the drill on the ridge; others on the flat surface. The choice between the two systems depends upon the character of the soil. Light gravels or chalks, it is said, succeed best when planted on the flat, whilst those of a loamy or more heavy character do best on the ridge.

The Berkshire farmers are fully alive to the value and importance of artificial fertilisers, and liberally expend their capital in the purchase of those which are best suited for their various occupations. The value of artificial manures is now so well understood by all agriculturists of intelligence, that they, with very few exceptions (owing to high cultivation or favoured position of soil), go now as regularly to the manure manufacturer for dressing for their root-crops, as to the market for corn or oilcake for their fatting stock. This demand has naturally led to the establishment of several bone-mills and manure manufactories in different parts of the county; one of which nearly joins my own parish, situate at Goring, and largely supplies the neighbouring farmers of Oxon and Berks with superphosphate of lime. Ammonia, or rather guano, in its cheapest commercial form, is admitted from experience to be the most certain artificial fertiliser for all corn-crops, while phosphates are proved by the same rule to be best adapted for the cultivation of roots. Bones in a state of division from dust to half-inch pieces are used very extensively on the down-land and chalk-range of hills in this county for all descriptions of roots, at the rate of from 8 to 16 bushels per acre, the cost to the farmer being from 20*s.* to 25*s.* per quarter, according to their fineness. But superphosphate of lime, when good and composed of bones dissolved in sulphuric acid, is more certain in its effects, and the most generally adopted manure; and such results have followed from the use of these valuable adjuncts in agriculture that thousands of acres in this county, which from their position would never have been reached with the dung-cart at a reasonable cost (and consequently must otherwise have remained in their sterile state) have been converted into highly-cultivated farms.

The root-crop has in such cases been the foundation of all improvement. This crop, consumed by stock (usually sheep) receiving oil-cake or corn in addition, paved the way for the growth of the succeeding corn-crops, so that many of these comparatively barren chalk-hills, that within the last ten years would hardly produce a turnip larger than an apple, have become, by the application of judicious fertilisers, highly-cultivated stock and corn producing districts.

The farm of G. B. Morland, Esq., at Chilton, near Harwell, is a case in point, which, from high-farming and good manage-

ment, often produces prize-stock and roots at the local and Smithfield shows.

It is almost superfluous to speak of the method of using superphosphate of lime. Ashes are procured sometimes from the peat-meadows, but more usually from paring and burning some worthless piece of down or rough bank, the labour of which costs about one penny per bushel: from 20 to 30 bushels of these ashes are mixed with 3 cwt. of superphosphate per acre, and applied by drill at a cost of 21*s.* for the superphosphate, and 2*s.* 6*d.* for the ashes, making the total cost less than 25*s.* per acre.

Another method, which is getting into very general use since the introduction of the liquid-manure drill, is that of mixing 300 gallons of water, or, better still, the drainings of a farmyard tank or pond, with 3 cwt. of superphosphate per acre. The action of the cups in the drill macerates this into a creamy fluid, and deposits it with the seed along the rows made by the drill; particular care should be taken to allow the harrows to follow immediately after the drill to cover up the rows, or the powerful sun in the middle of May or June is apt to bake the liquid and render it inoperative, until rain or some atmospheric moisture succeeds. It is a curious fact that the water or liquid-manure drill succeeds best in wet weather; experience, however, has proved such to be the case. Should there be moisture in the soil, or a little rain fall after the operations of the field are completed, the rapidity of growth is much greater than under any other method, and in a space of forty-eight hours the plants may be descried along the rows. Guano is used with good effect on strong soils, but if ammonia is required, 1 cwt. of guano mixed with 2 cwt. of superphosphate of lime is considered the more certain application. The use of the water-drill is generally restricted to the lower range of turnip-lands, from the difficulty at all times of procuring water for the purpose in the higher levels: where water is handy, and can be obtained at a moderate cost for cartage, it is found by experience to be the best safeguard against the "fly" in a trying season.

Another considerable source of fertilisers to many parishes near the downs, has been found in the establishment of training studs for race-horses. Gentlemen of the Turf find the invigorating gallop over the downs so beneficial to the training of their horses, that they have located themselves at East Ilsley, Compton, Chilton, Letcomb, Lambourne, &c., and by these means have much benefited a large tract of light soil (much shut out from the convenience of railway transit), by the quantities of horse-provender of the best description which has consequently been consumed, and the large amount of manure restored to the adjacent farms in return for a supply of straw.

Notwithstanding all these appliances, the turnip-plants may fall victims to the many enemies with which they have to contend; but, should they survive them on the land that has been drilled, the horse-hoe is put to work as soon as the plants are strong enough; on that sown broadcast the harrow is used, if the surface has become crusted by rain, so as to bring the plants as quickly as possible to the hoe.

Mangold, which in most instances is put in as early in April as the weather will permit, is generally hoed out the first time, and sometimes the second, before the hands on the farm are required for haymaking: in this case they always want a third hoeing later in the summer. There has been much diversity of opinion about the best time for sowing swedes. Some sow as early in May as the land can be got ready, contending that thus they run the least risk from the fly; but, as the soil is cold at this period, the plants are a long time coming to the hoe, and the hardier weeds, growing with unusual vigour from the stimulating power of the manure, soon choke them up. At best, if these difficulties are got over, after extra trouble and expense in hoeing, the crop is very liable to become necky, is frequently attacked in autumn by mildew, and, if not fed off early, is destroyed by the first severe frost, unless it is stored—a proceeding not now in much favour. Others prefer to sow later, *i.e.* about the first week in June, and I think they are right, as from my own observation I have found that swedes or turnips never grow freely till the lowest temperature, at one foot below the surface, is not less than from 52 to 55 degrees, which is seldom the case before June comes in. The plants sown at that time are frequently fit for the hoe in three weeks from the time of sowing, and are ready for the hands to begin upon so soon as the haymaking is completed. In most seasons, when the harvest is not unusually forward, they receive the second hoeing before reaping commences. Rape and forward turnips are sown directly before or after the swedes; the backward turnips that are required for winter or spring feeding not until the latter end of June or beginning of July, and even later, very frequently after a crop of peas, rye, winter barley, or vetches, have been taken; indeed many of the best farmers on the quickest soils, when kept clean, never think of having a naked fallow: these later sown turnips are hoed out as opportunities offer in the harvest, but this work is often obliged to be deferred till the whole of the corn is secured. Since swedes and turnips are yearly becoming a more hazardous crop, kohl-rabi has by many been recommended as a substitute. This has not hitherto been cultivated to any extent in this county, and the impression of most farmers at present is, that it takes

too much out of the land; whether necessity will compel us to cultivate it to a greater extent, in the absence of other alternatives, remains to be seen.

Barley and Oats.—The preparation of the land for the succeeding barley or oat crop commences as soon as the fields are cleared of the roots. When the weather will permit, it is ploughed up immediately after the sheep, so as to receive the benefit of the frost, and a final ploughing at the end of February or beginning of March is given before the barley or oats are sown; the land fed off later in the spring is mostly sown after once ploughing. Of late years barley is put in much earlier than formerly, as it is found that a better sample is grown. The drill has nearly superseded the plan of sowing broadcast; the quantity of seed is from $2\frac{1}{2}$ to $3\frac{1}{2}$ bushels of barley per acre, and from 4 to 5 bushels of oats, according to the condition of the land.

Where grass-seeds are sown the seed-barrow follows the drill and deposits the seed in the channels made by its coulters; if the land does not work fine, then it is harrowed and rolled before the grass-seeds are put in: the quantity of seed used is, for red clover and cow-grass 14 to 16 lbs. per acre; white clover 14 lbs.; sometimes a mixture of 6 lbs. white clover, 6 lbs. trefoil, and $\frac{1}{2}$ a bushel of rye-grass per acre is used on the lighter lands. Some people prefer sowing their grass-seeds after the barley is up, and merely rolling them in, but in dry seasons the former plan is considered best. When sainfoin is laid down with the barley or oats, it is drilled the opposite way, about 4 bushels of rough seed, or 60 lbs. of milled, with 8 lbs. of trefoil per acre.

Barley is either mown with the scythe or reaping-machine, and allowed to lay in swath till fit for carting, sometimes requiring a turning or two. The plan of fagging oats is much in favour, as it greatly economises labour and time in carting.

Grass.—That portion of the barley and oat field which has not been sown with grass is fallowed as early in the autumn as circumstances will admit, either for rape or turnips, or for beans and peas. The manure for the most part is carted on from the farmyards and spread before the land is ploughed. Beans and peas are sometimes mixed together—1 bushel of peas to 3 bushels of beans per acre.* The greater part of the Berkshire farmers may be said to rely entirely on hay made from artificial layers. This crop, therefore, is an important one, especially to the owners of breeding flocks of sheep, which depend very much on this resource for summer-keep. Of the layers mostly cultivated, the broad or red clover stands first, and produces large crops of excellent hay in the valleys and on some of the best land in the

* I consider this very slovenly farming, as it interferes with the proper cleaning of the land.—Editor.

county; but as the land from continual planting has in many instances become clover-sick, it cannot be relied on oftener than once in eight years, and on some land once in twelve years. Where the field is not of one uniform description of soil, the following mixture is often found to fill up those spots where the clover will not grow, 10 lbs. red clover, 3 lbs. white, 3 lbs. trefoil, per acre. On those soils where the first-named five-course system is carried out, white clover is alternated with the red, so that the latter does not come in more than once in ten years: where the four-course and the second-named five-course system is adopted, one-half of the field being planted with beans or peas, the necessity of sowing oftener is obviated, and on most of these farms there is a considerable quantity of meadow.

Trifolium and Italian rye-grass are grown in small quantities for early feed, or for cutting up for cattle. Cow-grass is also grown as green food for cattle, and produces extraordinary crops, coming in after the clover and other grasses are gone by; a few acres are much valued in July and part of August.* On the lighter soils and poor hills mixed seeds with rye-grass are sown, not from choice, but necessity; for on these hills it is a question of hay or no hay. Rye-grass makes good hay when cut young enough, but this is seldom done; consequently the quality is greatly deteriorated by the first storm of rain it takes.

Of all the layers there is none so valuable to the farmer on the chalk as sainfoin, and none that he can so well depend upon in dry seasons for a crop: there is much diversity of opinion as to the period it should be allowed to remain down. Mavor in his Report speaks of it as lasting for nine or ten years, and of then getting rid of it by paring and burning, a process now considered objectionable. I believe most farmers have come to the conclusion that only four crops should be taken; a few still contend that so long as it will grow 1 ton of hay per acre it should not be broken up. My impression is that four crops are one too many, and in this opinion I am borne out by some of the most practical men, on whose judgment I much rely. Most of the large farmers in the chalk district never keep less than sixty acres down, and some considerably more; so that if only three crops are taken by laying down twenty acres and breaking up twenty every year, there are always sixty acres to cut, although the first year it is generally allowed to seed. The advantages of taking three crops only are obvious; the land never gets foul, and, by being manured in the winter for the last crop, it requires once ploughing for wheat, and can be treated the same as the other clover-leys. From my own experience I can say that, in

* Lucerne and Holcus saccharatus are cultivated in small plots, but not to sufficient extent to require a lengthened notice.

most seasons, it will grow two sacks of wheat per acre more after three crops than it will after four; from the fact of the roots being in full vigour when they are ploughed up, they afford just that food to the wheat-plant which it requires, and, above all, the land is fresh to lay down again in eight or ten years if necessary.

The grasses are generally cut for hay in June and beginning of July, and the aftermath fed off by sheep. Mowing commences upon the rye-grass and mixed seeds, sainfoin following, the red and white clover coming last. When there is a considerable quantity to cut, great judgment is required to determine when to begin, so as to complete the whole in proper time, as the hay is quickly damaged by rain if allowed to get too old before it is cut.

I rejoice to say that the practice of carting-out the manure from the yards during the autumn and winter months, and spreading it at once on the young grass-seeds, is rapidly doing away with the objectionable plan of drawing it into heaps in the winter, to be put on the grass after the hay is cleared, and before the ground is ploughed for wheat: the consequent advantages are very great. The labour on the farm is thus equalized, which is exceedingly desirable. Employment is given in the winter months to those hands which, under the other plan, were often discharged, and from being deprived of the means of obtaining an honest living, frequently became the inmates of our gaols and workhouses. The quantity of hay grown thus is increased considerably; on some of the light soils to the extent of at least one-third. The ley-ground is ready for the plough at any time after the lattermath is cleared off, so that it can be broken up in good season, instead of waiting in backward harvests till hands can be spared for spreading the manure, much to the prejudice of the succeeding wheat-crop, and frequently to the injury of the manure itself, which then lies on the land in small heaps for several weeks together, exposed to the scorching sun of July and August. And lastly, this practice tends to increase rather than diminish the yield of the wheat-crop, not so much in straw as in corn; as, in consequence of the manure being well mixed with the soil, there are fewer lodged spots, and consequently less tailing-corn, and a more even sample. Artificial manures are not much used for corn-crops; guano or nitrate of soda mixed with salt is occasionally applied in the spring months to wheat and spring corn, to invigorate a thin-looking or sickly field or so; but the farmer relies more upon the resources of his farmyard for these crops than on any other means as a general rule. Within, however, the last five or six years a large trade has been done by the Great Western Horse-Manure Company, the proprietor of which (Mr. Tottenham) resides at Slough, and attends most of the markets in

the upper part of the county: the collection of stable-manure in London, from whence it is carted to Paddington, has been largely patronised by those farmers who are situate at a reasonable distance from the metropolis, and within easy reach of the various railway stations on the line. Something like 10,000 tons are annually distributed in this way, at a cost of 8*s.* per ton between Slough and Reading, or 10*s.* below Reading, delivered free at the station.

Wheat.—That part of the wheat-field which succeeds the grasses is first attended to, and is ploughed and sometimes pressed, when intended for sowing broadcast; but, as the drill is now in almost universal favour, the pressers are generally superseded by rollers and clod-crushers. Seed-time commences on the cold and poor soils at the latter end of September; on the better soils the last fortnight in October is considered the best season: the quantity of seed on the poor soils is 2½ bushels per acre, and on the best 2 bushels; in some cases less, according to the condition of the land.

The varieties of white wheat mostly cultivated are Chittam, Swan, Talavera, Trump, and the Rough-chaff Essex; the three former grow very fine in quality but are rather shy yielders, the two latter are of good quality and most productive. The red wheats most in favour are the Burrell, Red Straw, Lammas and Nursery, all good yielders and of good quality. Immediately the ley-wheat has been put in, the attention is directed to that which has to succeed—rape, turnips, beans, or peas; these lands having been previously manured require but little labour, and are sown at different times as the sheep clear the fields, which is frequently not completed till after Christmas. A good deal of the wheat on the light hills is rolled in the spring as soon as the sun and wind have dried the land sufficiently to let the rollers work; nothing more is then done to it except weeding; where it looks thin and has lost plant it is sometimes hoed.

The reaping-machine is used in some places with considerable success, but not to that extent which it deserves; the defect, however, is not so much in the machine as in those who have introduced it, as I shall show under the head of agricultural machinery. By far the greater part of the wheat is fagged, bound in sheaves and shocked in rows on the lands. When the lands run north and south this is a good plan, but on the contrary when they run east and west it is bad: in the former case, one side gets the morning, the other the afternoon sun, and as the wind is generally between south and west during the harvest months the shocks dry quickly, and in wet and unsettled weather will take a great deal to make them sprout; but when the shocks

stand the opposite way, the south side gets all the sun and wind. I have frequently in wet harvests seen the north side of the shocks one mass of green, when on the south not a grown ear could be found. I am surprised that my brother-farmers do not see the necessity of placing the shocks north and south, without regard to the way in which the lands or furrows run. As soon as the fields are cleared under the four-course shift, the preparation for the succeeding root-crop commences, as before described; but under the five-course shift the usual mode was to plough up the stubble, let it remain till the following spring, and, if clean, then drill in the barley or oats on the back: this has now much given way to the improved plan of cleaning the stubble in autumn with the skim-plough or scarifier.

So far as my own experience goes, and the information which I have obtained from others, the above description of the mode of tilling and cropping is that which is carried out for the most part in this county; there is, nevertheless, some land in the Vale district where the soil is very stiff and wet, upon which no system is or can be adhered to. Where so much depends on weather and other circumstances, it is impossible to give an exact description of the methods adopted.

Drainage.

No subject of late years has been more fully discussed and more widely canvassed, both in public and private, than that of draining; so much so that to write a long chapter on one system or the other would be invidious, more particularly in a county where drainage forms so unimportant a feature: for it may safely be said that few counties in proportion to their area have so small a surface requiring that adjunct as Berkshire. Suffice it, therefore, to say that the greater part has already been done on the most approved system, and that which remains is in contemplation.

Beginning on the east side of the county, the first soil we meet with requiring drainage is that portion in Windsor Park which lies between the alluvial soil of the Thames valley and the Bagshot Sand, including the Flemish Farm, described under the head of the Royal Farms: as we pass on to Winkfield, Warfield, and Binfield, in the direction of Wokingham, thence to the south side of the county beyond Mortimer, we again find a tract of land of the London and Plastic Clay formation, which invariably requires draining. From information which I have obtained, I find that this work has been executed nearly over the whole district on the plan most generally approved,—that is with drains parallel to the incline, 4 feet deep and 24 feet distant, laid with 2-inch pipes. The cost is—for pipes 24*s.* per 1000; for cutting the drains and

laying the tiles from 6*d.*, when the soil is of an uniform clay, to 9*d.* per pole, when the clay is mixed with gravel. The landlord generally does the draining, the tenant paying 5 per cent. on the outlay and carting the tiles.

We find no more draining of any consequence until we descend into the valley of the third division, where the same system has been carried out to a great extent: there is here, however, some land still undrained, a small part of which lies so low that no fall can be obtained; such land, for the most part, is in grass. In this division is a large estate at Buscot, which for many years had been entirely neglected and almost left to its fate, but has recently been purchased by Mr. Campbell. The new owner has just commenced draining on a large scale upon the deep system, and purposes doing the whole estate; the result is looked forward to with the more interest as the steam-plough is about to be introduced for its cultivation. When another Report on the farming of Berkshire shall be written, it may have to be recorded of this estate that, what up to this period was a cold and sterile clay, has become one of the most fertile and productive parts of the county.

Grass-Land.

The character and quantity of the Grass-Land is not of sufficient importance to require a very lengthened notice. Without any authority on which to rely, I do not think I am far wrong in estimating it at about one-sixth, or 75,000 acres.

I find that the farms on the north side of the county have about one-third in grass, other parts of the Vale district from one-fourth to one-fifth, the central part from one-seventh to one-eighth, and the south part about one-seventh. On the whole these pastures are far from good, but their management is still worse; and in these days, with every appliance at our command, it is difficult to reconcile the total neglect of our poorer grass-lands with the attention and outlay bestowed on the arable. Is it that they are naturally poor beyond all power of improvement? or that they are useless for any purpose? Certainly not. Is it not rather a proof that the improved breeds of stock of the present day are too good for the feed they can produce, and that the produce of 1 acre of well-cultivated arable-land will feed more cattle well than 20 acres of such pasture would maintain in poor condition? And, notwithstanding all that is being said and written on the subject of breaking up such useless grass-lands, is there any greater proof required than the fact of their neglected condition, to show that they are neither valued nor wanted? I am speaking here of those lands which produce bad herbage, and are not liable to frequent floods. There is much of such land in the

Vale district, and some in other parts of the county; a part has been broken up within the last 20 years with good results, but much more remains to be done.

There is a considerable quantity of meadow-land on the edge of the Thames and a little on the banks of the Loddon, of varied quality, some very serviceable, some very coarse, either from want of draining or from the flood-water lying too long upon it and destroying all the more tender herbage; this may be much improved by attending to the river, but no care whatever is taken to free the land rapidly from flood-water.

The meadows in the neighbourhood of Lechlade will graze a beast and at the same time would starve a horse: these are occupied for grazing and feeding young stock, and for dairy purposes, and many of them are mown for hay once in the year. There is some excellent pasture in the neighbourhood of Wantage, Hanney, Ardington, Grove, Steventon and Milton, producing hay of good quality and valuable for grazing purposes. These pastures are better attended to than those previously referred to, as are also the lands occupied in other parts of the county by gentlemen's parks, paddocks, or by enclosures surrounding homesteads, &c.; they are occasionally dressed with road-scrapings, either by themselves or mixed with manure from the yards: the parks, where no deer are kept, are mown once in the year, the after-feed being in some cases let to dealers or butchers.

A range of valuable water-meadows lies on each side of the Kennet and of the Lambourne, from Shefford to Newbury, and a small quantity by the stream running from Hampstead-Norris to Pangbourne. These are usually fed off in the spring, from April to the middle of May, with sheep, being let for 3*l.* or 4*l.* per acre for the feed—in some backward springs they make more. They are watered from the middle of May to about the middle of July, then cut for hay and afterwards fed up to the end of November, by cow-stock and horses. In some cases the spring-crop is mown instead of being fed; this hay is more valuable than the second crop, but requires great care in making: the process of making hay is too well understood to require explanation.

Remarkable or Characteristic Farms.

Berkshire is favoured with as wealthy and influential a body of landed proprietors as most counties, who are ever foremost in giving a stimulus to agricultural improvements. There are many large estates, but the greater portion is in the hands of smaller proprietors. It will be impossible here to mention every farm worthy of notice; but, as several of the largest landowners have in their own hands a farm which they cultivate upon the most improved systems, I have selected three or four of those, the

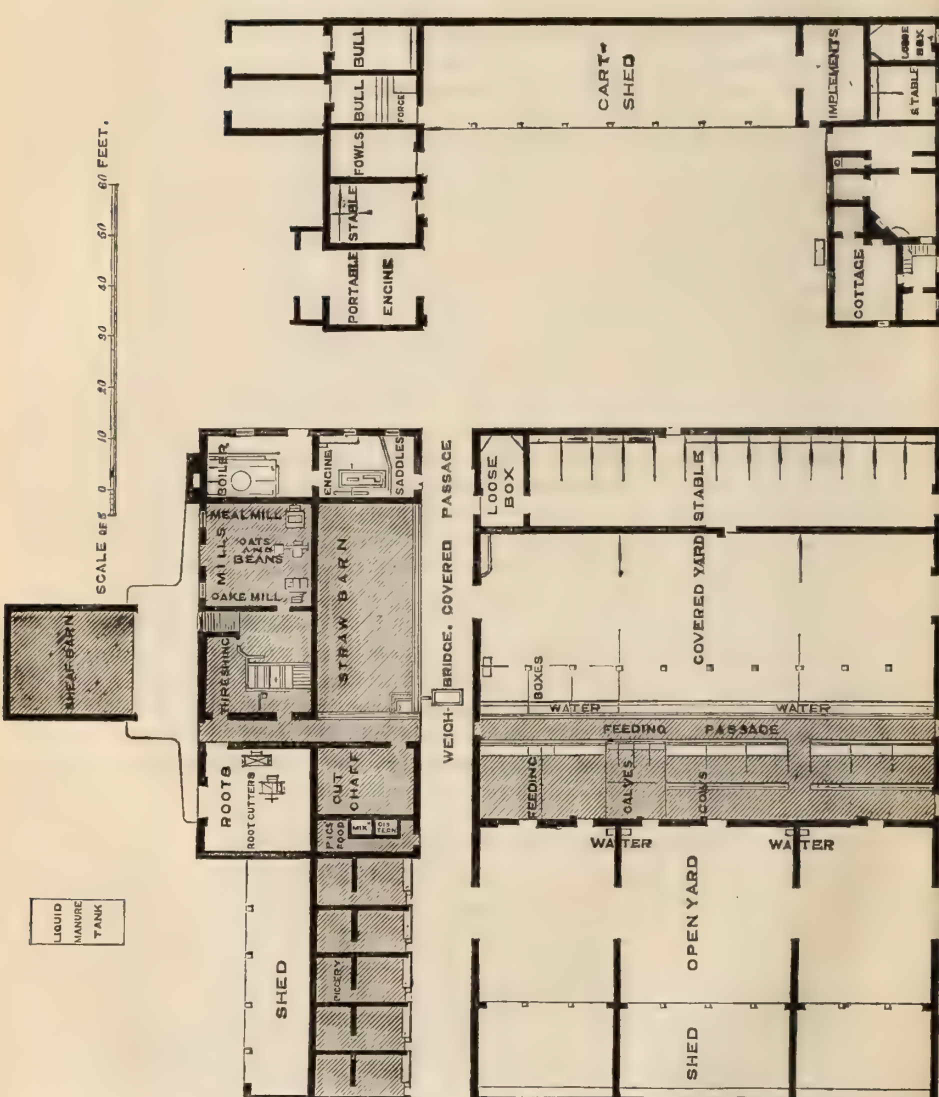
FLEMISH FARM.

PLAN OF FARM BUILDINGS

ERECTED BY

His Royal Highness the Prince Consort,

1858.



buildings, stock, implements, and machinery of which would be an ornament to any county. I shall speak first of those belonging to His Royal Highness the Prince Consort, in Windsor Great Park.

The Flemish Farm, containing 400 acres, of which 240 are arable and 160 pasture, is a very stiff soil, being on the London Clay. It has all been drained on Parkes' plan, 4 feet deep, at a cost of 3*l.* per acre, exclusive of pipes and cartage: it had been previously drained on the shallow system. Here His Royal Highness has displayed great practical ability in the erection of one of the most complete and convenient homesteads of the present day, with such regard to economy as to bring it within the reach of private individuals. The design is by J. R. Turnbull, Esq., architect, Office of Works, Windsor Castle, to whom I am indebted for the accompanying plan. The simple style of roof, with Beedon's patent tiles, is worthy of adoption in all agricultural buildings. Among the many accommodations are houses for dairy and breeding cows, with open yards and sheds attached, covered yards for fattening beasts, good stable, piggeries, &c.

GRANARY. SHEAF BARN. ROOT HOUSE.

OPEN YARD. COW HOUSE. COVERED YARD. STABLE.

This plan of the Flemish Farm will show the general arrangement of the buildings, with the exception of the granaries, which extend over the mill, boiler, and engine-rooms, and lead directly from the threshing and winnowing machines: the chaff and litter cutters are placed on a floor over the chaff-room and a portion of the straw barn, so that the cut falls ready for use in the covered yards and stables. Great attention has been paid to the ventilation of these yards by raising the roof on each side to give a free current of air. The thickness of the Bridgewater tile secures a cool temperature in summer and warmth in winter.

Messrs. Clayton and Shuttleworth put up the whole of the machinery, consisting of one of their 8-horse power fixed steam-engines, which works a thrashing and winnowing machine, manufactured by them ; a chaff-cutter made by Messrs. Cornes ; an oat-and-bean-crusher by Messrs. Turner ; a cake-breaker by Messrs. Garrett ; a litter-cutter by Messrs. Ashby ; a root-cutter by Messrs. Gardner ; and a pulping-machine by Messrs. Bentall.

A steam plough and engine of 12-horse power, made by Messrs. Fowler, have also been recently introduced.

The four-field „ system of cropping is usually carried out, but occasionally an extra crop is taken between. Part of the manure is carted out for the root-crop, and the remainder on the young grass-seeds in the autumn and winter months. An excellent quality of white wheat, and good beans and oats are grown, but an inferior quality of barley. The soil not being so well adapted for sheep, the roots are principally consumed in the yards by the cattle, which at this farm are all of the pure Hereford breed of the best blood, a distinct breed being kept at each of the farms. If I may judge, His Royal Highness bids fair to gain great renown, not only as a grazier, but as a breeder of pure Herefords, Devons, and Short-horns, as no expense or care has been spared in the selection : they are too well known to the public to require further comment on my part. The breed of horses is a cross between the Suffolk and Clydesdale, and is of a superior description. One of Smith's steam-ploughs has been used for some time with great success ; this has now been sent to His Royal Highness's farm at Osborne, and replaced by one of Fowler's. All the other implements and machinery are of the most modern make.

The Norfolk Farm consists of 700 acres, of which 200 are under the plough, and 500 in grass ; being on the south side of the park it belongs to the Bagshot Sand formation, upon which there is a considerable deposit of gravel, and is altogether a lighter tillage. The homestall is of ancient date, with thatched barns, open yards, and sheds : these buildings are nevertheless very convenient, and prove that, with proper care and attention, prize beasts can be produced, even without modern homestalls. Here we find a very superior herd of 30 Devon cows, pure in blood, and beautiful in symmetry ; Devon bulls, of all ages, that have already won several prizes ; and some very promising steers and young stock, that bid fair to answer every expectation.

The same course of cropping, manuring, &c., is adopted as at the Flemish Farm, the horses are of the same breed, and the implements of the same uniform description.

The Home or Shaw Farm, comprises 900 acres, of which 130 only are arable and 770 pasture. That part which is near the

Thames is of a rich alluvial soil, with a mixture of gravel; the other is on the London clay. The farmstead is of the most costly kind, and almost baffles description; here and at the dairy farm-buildings, are to be seen about 270 head of pure short-horn cattle, from the blood of Messrs. Booth and other first-class breeders, of which 100 are cows kept for dairy purposes. Among them are many beautiful cows, of well-known pedigree. The Royal dairy, recently built, is in itself a perfect gem. The pigs are of the much-admired Windsor breed, and have often successfully competed at the different cattle-shows. The horses are the pure Clydesdale, and are fine specimens, being both active and powerful; they are bred on the farm: this breed has also been on the prize-list of the Royal Agricultural Society. I have omitted to speak of the sheep, as, from the nature of the soil, they do not form a prominent feature: there is, however, at the Shaw Farm a flock of Cheviot ewes, for breeding purposes; at the other farms dry flocks are kept which are bought in as circumstances require.

Not the least pleasing feature connected with the Royal Farms is the provision made for the instruction and comfort of the single carters and boys, who live on the premises in a very suitable and well-arranged house, a schoolmaster attending regularly in the evening for nine months in the year, to give them any instruction they may think proper to avail themselves of, a privilege from which the married men are not excluded. Her Majesty the Queen, with the same care and interest which she has always manifested for the welfare of her poorer subjects, has provided most appropriate schools in the centre of the Great Park, with well-qualified schoolmaster and schoolmistress, for the instruction of the children of those who are employed on the Royal domain, and, by her liberality, they are also clothed and daily supplied with their dinners. It is to be hoped that this bright example will be more and more imitated by all her subjects. Here I feel bound to express my thanks for the great courtesy I received from the Hon. Colonel Hood, and the facilities that were afforded me for inspecting the Royal Farms by Mr. Brebner and Mr. Tait.

The next selected farm for notice is the Earl of Radnor's, of Coleshill Park. It comprises about 700 acres, of which nearly 300 are arable and 400 grass. The farmstead is very complete. There is accommodation for a dairy of 40 cows, boxes for fatting, and stalls for tying-up, bullocks; yards and sheds for breeding cows and young stock; also a sheepyard and fatting-shed; piggeries, stables, &c. The machinery, by Clayton and Shuttleworth, for threshing, sacking, and weighing the corn, grinding, pulping, bruising, chaff-cutting, sawing, &c., is in every respect well arranged.

The character of the soil is very various. Towards the west the coral-rag prevails on the hill, at the base of which runs the Cole: this river divides the counties of Berks and Wilts for a considerable distance. The land on the slope is generally good: on the south-east side there is stonebrash, with a sandy loam; the intermediate slopes are various, and at the base of the hill is the Oxford clay. The grass-land generally is grazed for dairy purposes and is very variable in quality: on the slopes it is dry, healthy, and very productive; so also is the best of the strong loams lying on clay when well drained, but there are fields adjoining Buscot which are cold and unproductive.

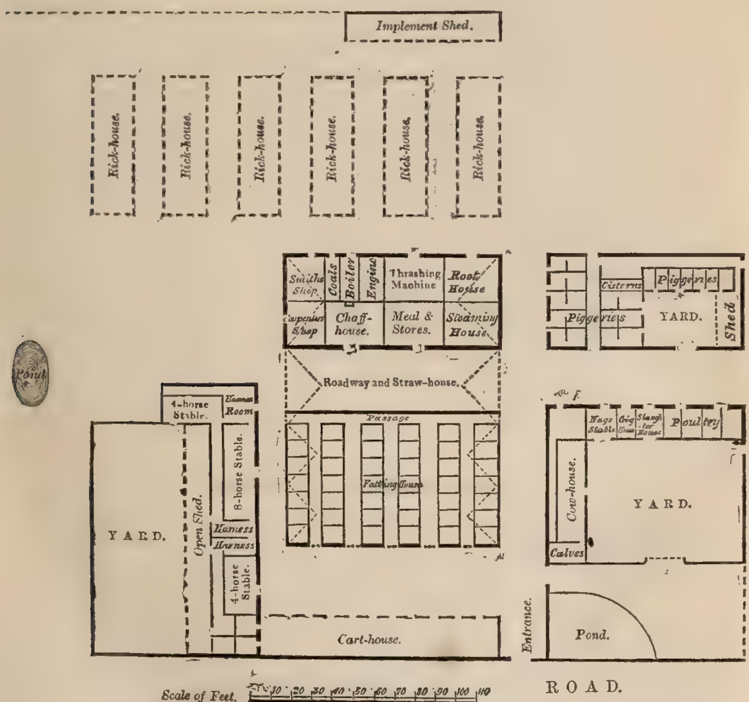
The system of cropping generally adopted is the 4-course shift, but it is continually varied, as it is found that with high feeding too much straw would otherwise be grown: 250 quarters of oats, 100 quarters of beans, 40 quarters of barley, 25 tons of oil-cake, with a good deal of inferior wheat, beans, and peas, are, on an average, consumed in the year; large quantities of mangel-wurzel are grown. There are 17 cart-horses employed: they are frequently used for timber-hauling on the estate.

The neat cattle are of the pure short-horn breed, from the herds of Messrs. Booth and other well-known breeders; 140 head are kept, consisting of 60 cows and heifers, 20 steers, 40 cow and bull calves, bulls, &c. There is a breeding flock of pure South-downs, from the stock of Messrs. Jonas Webb, Northeast, Throgmorton, &c.: 400 ewes, 200 ewe tegs, 150 wether tegs. The pigs are of the Coleshill breed, and have gained much reputation at many agricultural shows; some of this stock have been sent to nearly all parts of Europe.

With all this attention to the breeding and rearing of stock, I am pleased to add that the well-being and condition of the agricultural labourer has not been overlooked by his lordship. The village of Coleshill has been rebuilt. The cottages, containing as a rule three bedrooms each, and with 40 poles of ground attached, are of a superior description; others are still being built as required, especially on farms where there is not sufficient cottage accommodation. I am told by a friend residing in the neighbourhood that his lordship is always ready to promote and assist in every benevolent work in the widest sense of the word. For some years past he has given prizes, not restricted to his own tenantry or labourers, for the best mowing, shearing, drilling, and other agricultural operations, and also for the best pieces of swedes, mangolds, &c. A village flower and vegetable show also takes place every year. These encouragements to good cultivation, good work, and, above all, decency of living, already show signs of good fruit, which must increase and extend as time rolls on. I am much indebted to

E. W. Moore, Esq., his lordship's agent, for the information he has kindly given me.

The chalk-pit farm of R. Benyon, Esq., of Englefield House, also calls for especial notice. Its extent is 546 acres, of which 300 are arable, 200 pasture, and 46 water-meadows. The soil generally is a rich gravelly loam; the hills are heavier tillage, being a mixture of the sand and clay of the plastic clay formation on a chalk subsoil; the whole is suited for the production of all kinds of grain. The system of cropping is a 5-course:—1st year, Wheat; 2nd year, Roots; 3rd year, half Beans, half Roots; 4th year, Barley or Oats; 5th year, Grass, one-half red clover, one-half hop and Dutch. This is the best modification of the old 4-course system I have met with in the county. Much more could be written in its favour than the limits of this Report will allow; its greatest recommendation is that it provides for a large quantity of stock, and ensures the crops being put in in good season. The manure is carted-out on to the young grass-seeds in the autumn and winter, except that part which is required for the root-crops.



CHALKPIT FARM BUILDINGS, ENGLEFIELD, BERKS.—R. BENYON, ESQ.

It will be seen by the subjoined plan that the buildings are extremely convenient; they do not perhaps present to the eye so compact and uniform an appearance as some others, but in their selection great practical judgment has been displayed without any useless expenditure of money. They afford good accommodation for a considerable quantity of stock, and facilities for making a great deal of manure; consequently they are peculiarly adapted for large arable-land farms. There is stable-room for 16 horses, with water turned on in each stall from a pond at a considerable elevation above, which supplies the whole farmstead. The manure is taken from the stables into an adjoining yard, which is open, but provided with a shed; it is here mixed and trodden down by the young cow-stock. There are also loose boxes for 42 beasts; a commodious cowhouse, with open and spacious yard; piggeries, well arranged, with breeding-styes opening into a yard with shed. Here are to be seen the much-wanted rick-sheds, which I shall refer to elsewhere.

The machinery, which is by Messrs. Clayton and Shuttleworth, is very superior, and the arrangement for thrashing, grinding, pulping, bruising, chaffcutting, &c., on the upper floor is very convenient. The farm horses are good, they are bred on the property, and are slightly crossed with the Flemish blood. About 200 head of superior short-horn cattle are kept for dairy and grazing purposes; a dry flock of 600 sheep, to fold on the land, and pigs of the improved Berkshire breed. The implements are of the best description; Scotch carts are used instead of waggons, and Smith's steam-plough has worked on the property for some time with most satisfactory results. The attention which is being paid to the dwellings of the poor on the estate and to many other improvements connected with them, which the short residence of Mr. Benyon on his property has only enabled him partially to carry out, characterises him as one among that body of English landlords of whom the farmers of this country are justly proud. I have to thank Mr. Benyon for the plan with which he has kindly furnished me, and for the information he has allowed me to obtain.

Homesteads and Manure.

To say that the homesteads of Berkshire are good and in most respects well maintained is no more than correct, but the site of many of them is far from well chosen, nor do they in all cases meet the requirements of the several occupations. In such instances the misfortune is that they are too good to pull down and of little value as they stand; for, under the present system of farming, it is impossible to cultivate the land to the best advantage with a misplaced or badly-arranged farmstead.

In a great many places we find the buildings have been erected from time to time as occasion required, without any regard to unity of design or uniformity of style, and are so ill-connected as to render it impossible to carry off the water from them, which is allowed to saturate the manure in the yards, and, after extracting much of its valuable property, to run off, through some drain, to the nearest pond, cesspool, or ditch.

The Berkshire farmers are quite alive to the value of good manure, and do not spare expense in making it by keeping their yards well filled with stock and well littered with straw, of which they have an ample supply in consequence of so great a portion of their land being arable, which also their covenants often prohibit them from selling. The average quantity of rain that falls is no more than is required to moisten and make the manure, when the buildings are so arranged that the water from them can be carried off and not allowed to run into the yards; but where they are unconnected, as I before described, much injury is done to the manure which the farmer has no means of remedying: even if he turns the drainings to a good account, as many do, he still remembers that it is first robbed from his yards.

The large sheep-farms in the centre of the county are notorious for the inconvenient situation of the homesteads. In most cases the farms are laid out so as to take in a portion of the vale, hill, and down-land, and run in narrow strips of not more than half a mile in width, and of two or three miles, or even more, in length; here we almost invariably find the homestead placed at the extreme end in the village, with a few plots of meadow around it. Hence arose the necessity of constructing what are generally called the "down farms," which often consist of one or two barns, a shed, stable, yard, and cart-house, with one or two cottages. A few carthorses stand here, and here some of the corn is stacked that the straw may be converted into manure near at hand, in order to save the carting both of corn and manure. On some farms there is a lone barn or two in addition to these, where a yard is made for the sheep to pick over the straw grown close at hand and make it into manure.

This state of things is very unsatisfactory in one respect, and must undergo a change as the condition of the poor improves. No respectable man with a family cares to live in these lonely situations, where, in addition to other inconveniences, his children are almost deprived of the means of education. Under-carters and boys of good character, who are required to attend to the horses, mostly object to such isolated places, where they are deprived of the means of improvement, and, in most instances, their comforts are uncared for: consequently, we often find the most unsatisfactory characters settled in these localities.

It is not to be supposed from these remarks that the country is destitute of modern homesteads: several such have been built, within the last few years, for the use of the tenant-farmer, an instance of which may be seen on the property of J. C. Garth, Esq., of Haines Hill, near Twyford, who, in addition to the very compact and convenient covered homestall, with most perfect machinery, which he has erected on the farm in his own hands, has built, within the last few years, two homesteads of similar construction for tenants, and has commenced a third. The cottages on this estate have also been greatly improved. Another very compact covered farmstead may be seen at General Dunn's, Inlease, near Hungerford. These, with many others, which I cannot here particularise, show that the spirit of improvement is abroad.

Although the farmers of Berkshire may justly be proud of their ricks, so neatly made and beautifully trimmed, yet I should much rejoice to see them done away with, and rick-sheds adopted instead; for if there is one improvement required more than another at the present time, I believe it to be this. Every practical farmer must be aware of the damage which ricks sustain in the summer by being left open and taking rain before they are thatched,—in many instances to an incalculable amount. The expense of thatching and trimming is of itself considerable, and this work comes too at a time when hands can ill be spared for the purpose. Moreover, a change of weather often occurs before the task is completed, and the ricks have to be covered up, or, in too many cases, left open to take damage. All this would be obviated by the substitution of the much-desired rick-sheds, such as are to be seen on the farm I have spoken of, belonging to R. Benyon, Esq., of Englefield. In all the modern homesteads there is a great disposition to do away with barns, but the farmers will be very loth to give them up and entail upon themselves the necessity of making an extra number of ricks, until something is introduced to take their place. Much more may be said on behalf of rick-sheds, such as the facilities they afford for threshing, stacking straw, &c. Under this head the annual saving to the farmer would be quite equal to 3 per cent. on the outlay, without reckoning anything for the damage he now sustains.

The only objection I have heard of as at all likely to be raised against them is, that they are liable to be infested with rats and mice. I do not think, however, that this objection can be maintained, as such injury may easily be obviated by any one who will only take the trouble to seek a remedy. No one can have any excuse for his premises being stocked with these vermin. I may be considered severe in my strictures on the preservers of these, if I use an expression which I have often employed,—that rats and mice and slovenly people are generally found to be

located together. Some may say that this riddance is easier to talk about than to accomplish; but having, in more than one instance, entirely extirpated these pests from situations where they once swarmed—an undertaking in which their proximity to water rendered the task peculiarly difficult—I feel authorised to speak decidedly on the subject. No extraordinary means are required, but simply to keep a tidy rick-yard, with no heaps of loose straw or litter lying about, and to keep the barns well cleared out as soon as the corn is threshed. The stock can then be easily killed down; and if afterwards a trifle is paid for each rat killed, if the ricks are dressed in the usual way and some good cats are kept, another invasion of rats need not be feared. To prove that there can be no objection to placing corn on the ground, I have, within the last four years, taken down ten or twelve rick-stands, as from observation I found, when the ricks were threshed, there were always fewer mice in those standing on the ground than in the others on stands. The mice are brought home at harvest in the corn, and when put on stands are preserved there; whereas, when put on the ground, they get to the outsides of the rick, and are either killed or make their escape.

Farm Horses.

This county is not celebrated for any particular breed of horses. A good many farmers, who have the accommodation of a few pieces of pasture land, breed two or three colts yearly, which are broken-in when two years old. For the first two years two colts are generally reckoned to do the work of one horse; by this means one of the oldest horses is sold out each year and the team is kept young. But the greater part buy at the local fairs in the neighbourhood the colts which are brought by dealers from the north: by buying in two or three every year and then selling the oldest horses, efficient teams are kept up. Others still continue the practice of buying good colts at from 35 to 45 guineas each, and then of making up two or three of their best horses yearly, of which high prices are made for the London drays; in this case the older horses are often nearly worked out.

About four horses to every 100 acres of ploughed land are kept on the heavy soils, and three to the 100 acres on the lighter soils, where the threshing, chaff-cutting, &c., is done by steam-power. On the whole the horses are good and well chosen, so much so that I may almost venture to say the character of the horses shows the character of the soil on which they work: on the light tillage lands they are clean and active, sometimes crossed with the Suffolk; on the heavier soils they are rather less active and more powerful, but not of the old fashioned hairy-legged breed, a specimen of which is now seldom seen in the county, although

at the date of Mavor's Report such seems to have been the prevailing breed. The horses are generally driven three in a plough in the winter months, and two in the summer, on the light soils; but, on the heaviest, four are sometimes used. One acre per team is considered a fair day's work when fallowing or ploughing ley-ground, and $1\frac{1}{4}$ acre of tilled land; they generally work 8 hours, from 7 o'clock to 3. Some, whose farmsteads are central, rest them an hour in the middle of the day, and work an hour later; but this does not answer when the fields are far from home.

Neat Cattle.

From the small proportion of grass-land it will naturally be inferred that neither dairies nor grazing form a very prominent feature in the county; but as the principal part of the grass-land is in the Vale district, it calls for a special notice. Here dairies for the most part prevail, the management of which is such as has been often described. Most farmers rear a few calves, but generally they are sold at about 10 days old; the cow-calves being bought by the dealers to send back into the districts from whence they obtain the heifers in calf: in some instances the same calves are repurchased when rising three years old, when, as it is termed, they are down for calving. The cattle are mostly of the short-horn or rather Durham breed, without regard to pedigree; but there are more pure-bred bulls used than formerly; several of the landed proprietors keeping first-rate short-horn bulls, of which they allow their tenants and neighbours the use: consequently a very visible improvement is taking place in the quality of the cow stock. Some oxen and steers are kept for eating the poor grass in the summer and for feeding and making manure in the winter.

In the upland district, dairies and grazing form quite a subordinate feature. At Mr. W. Champion's of Calcot, near Reading, however, a good breed of short-horns may be seen. On those farms which have a considerable proportion of pasture some short-horn cows are often kept; where there is but little, two or three Jersey cows, or a cross between Jersey and short-horn, suffice for supplying the family with milk and butter. Some of this cross produce large quantities of butter: I have been told of one which last year gave 400 lbs., besides fattening her calf. A few teams of oxen are worked (mostly of the Devon breed) on those soils which are suited to their hoofs, but they are not much in favour or in very extensive use.

Pigs.

Berkshire has ever been celebrated for its breed of pigs, and most justly so, where proper attention has been paid to their

selection; but, as no animal degenerates so quickly, the greater judgment is required in saving proper ones for stock. Most farmers breed their own, let them run the yards and stubbles as stores, and afterwards fatten them for market. Some prefer selling them out as stores, particularly in the grass district; others, instead of breeding, buy in at about three months old to work their yards, and sell out again as strong hogs, or fatten them out when there is a prospect of their paying.

Some few have sought to improve the Berkshire pigs by crossing them with the Suffolk, Sussex, and other breeds, and named them (or rather I should say misnamed them) the Improved Berkshire. The quality of this cross, although it may appear successful for a time, cannot be kept up; consequently these gentlemen find (or will find) that they have a breed of animals deficient in constitution, deficient in natural flesh, and worthy of anything but the name of an improved Berkshire, which I believe can only be justly given to the pure-bred animal, the offspring of carefully selected stock. I may be thought severe, but I speak from experience, as I fell into this error myself some years since. Having previously been successful in exhibiting pure Berkshires, I was tempted to try to improve them by crossing, and so far succeeded as to obtain a prize for a boar-pig, called the Improved Berkshire, at one of the shows of the Royal Agricultural Society. I could not, however, keep up the quality of this breed by any means. The store pigs were much more tender, and required more nursing; they fattened well, but were deficient in lean; and the bacon lost considerably more weight in cooking than that of the pure-bred pig: consequently I was obliged to clear out, as my expectations were not realized, and begin again with pure blood. Had I not previously known the good qualities of the real Berkshire, I should have been satisfied with this cross.

Sheep.

Sheep-farming forms a very important feature in this county. There are three descriptions of flocks kept, viz.—regular breeding-flocks, breeding-flocks for selling and grazing, and dry flocks. As their management engages so much time and attention, and the profit derived from them forms a considerable item in the farmer's balance-sheet, it will be desirable to speak of each separately, more especially of the regular breeding-flocks, which are the most numerous, and are, with a very few exceptions, of the Hampshire or West-country Down breed. There is, however, a pure Southdown flock on the farm of Sir R. Throgmorton, at Buckland, and two or three cross-bred flocks in other parts of the county. The number of sheep kept per acre is from $1\frac{1}{2}$ to 2—*i.e.*, at the commencement of the year we find, on a farm of 500

acres (exclusive of Downs), about 450 ewes and 400 tegs; of these tegs about 160 of the best ewes are drawn out for stock, and kept in a flock by themselves upon Swedes and hay, both cut for the most part; the others, living by the side of them, have, in addition, 1 lb. of oil-cake or 1 pint of beans per day, and are sold out in the spring at some of the fairs, or sent to the London market, in which latter case they are generally shorn first: occasionally, however, in the preceding autumn some or all of the wether lambs are sold out at the later fairs instead of being wintered, according as the prospect of keep is favourable or the reverse.

The ewe-flock, consisting of 150 two-tooths, 150 four-tooths, and 150 sixth-tooths, lamb down in the early part of February: a lambing-pen is made, in the corner of the field where their food is, with thatched hurdles, or the ewes are removed to a convenient lambing-yard at the homestead, where they are fed on hay with turnips or mangolds; as soon as the lambs are strong enough they are removed into the field. The lambs soon learn to run forward and feed on the green top, and are often supplied with a few peas, and some cake, and chaff.

The roots are generally made to last until the beginning of May (where there are no water-meadows), by which time, in most seasons, the early rye, winter-barley, and vetches are fit to feed. The ewes are generally taken from the lambs at the end of May or beginning of June; where there are downs the ewes are driven to them daily, and folded at night either on fallows or an inferior piece of grass, as circumstances and the quality of the downs require; some of the downs are good enough to get the ewes up into condition without any other assistance, others are inferior, so that the stock on them require a good fold of grass at night. The sale or draft ewes, being the 150 oldest, are soon drawn out from the others and kept better, to get them fit for sale; some few sell them immediately they are taken from the lambs, in the wool, but most shear them, and sell them out about August.

After the lambs are weaned they require two kinds of food, and generally, so long as the vetches last, they have a fold of grass with them; soon after the hay is cleared they get a run out on some of the inferior grasses which are not likely to produce good after-feed, and, when the vetches are finished, they fold on the best lattermath. Here it is that the lambs often get a check which it takes them months to recover from; for in dry seasons, such as the last two have been, their supply of food is scanty till the rape is fit for use, which is not often the case till the middle of August. Upon this the lambs are sure to thrive if they have not been too much checked

before, particularly if they have a piece of sainfoin to run out on. After the rape is cleared, the forward turnip-land, which is to be planted with wheat, is next fed off; here the ewes fold behind the lambs, and clear up after them.

The rams are turned to the ewes about the end of August or beginning of September. These are extensively purchased from the well-known flocks of Mr. Humfrey, of Oak Ash, near Wantage, and Mr. Stephen King, of Old Hayward, near Hungerford, who have long been celebrated as breeders of Hampshire or West-country Downs; Mr. T. Fuller, of Compton, near Ilsley, has also been a successful breeder for the last few years.

Breeding-flocks for Selling or Grazing.—As cross-bred sheep have increased much in favour within the last few years, those who produce them have been obliged to sacrifice their own stock and go into the market for their ewes; these are purchased at the fairs in this county and Hants about July and August, and are the sale or draft ewes from the regular breeding-flocks: younger ewes may now and then be bought, but they are comparatively few. The ewes are put to white-faced rams, of the Gloucester or Leicester breed, and throw their lambs very early. Some fatten their lambs and ewes together; others treat them as store-stock, and sell out in the autumn; and a few fatten their tegs, and send them to the London market in spring, after taking their wool. This description of flock is very remunerative when ewes can be bought in at a reasonable price; but, when this plan is too generally adopted, an undue demand is created for them, and they sometimes cost more than they make when fattened, and, if they are not fattened, but sold again (sometimes to breed another lamb), a considerable sacrifice has to be submitted to.

Dry-flocks.—Several of these are to be found in different parts of the county, although they bear a small proportion to the whole. These, in many instances, are bought in as lambs or two-tooth sheep in June and July, and sold out in the following April and May, for the most part fat. Some farmers keep fattening out and buying in, as they have room and feed; here the cross-breed are decidedly in favour. About two sheep per acre of these two last descriptions of flocks are kept in most seasons; but the number varies according as the prospect of keep is good or bad.

It would be out of place here were I to recommend one description of flock in preference to the other; the farmers of this county generally are too good judges to suppose for a moment that it is a matter of fancy or opinion as to which they should keep: circumstances over which they have no control ought, and I believe do, most frequently decide the

question. Much may be said in favour of each, and each also has its drawback. Those farms on the best soils, which are mostly of one uniform description of land (upon the natural produce of which sheep thrive), may be considered most adapted for dry-flocks and the fattening of ewes and lambs; while, on the other hand, those soils which are very variable, with downs and down-lands attached, are certainly best calculated for breeding-flocks. Nothing has improved in this county so much within the last fifty years as the breed of sheep and the cultivation of those roots on which they so much subsist, for, at the date of Mavor's Report, in 1809, he speaks of the Swede or Ruta Baga as one of the most recent introductions, and the horned sheep of Wiltshire and the native Berkshire nots as the principal breeds of sheep kept at that period: these are, happily, quite extinct.

Agricultural Machinery.

Nothing affords a better criterion by which to judge of the improvements that are taking place in a district than the character of the implements in use. In this respect Berkshire is by no means in the background. In passing through different parts of it, we find, in almost every parish, many of the most modern inventions. The iron ploughs by Messrs. Howard, Barrett, Hart, Plenty, Haslam, Ball, and others, have entirely superseded the old wooden plough. The Cambridge and other improved rollers are much preferred to the smooth ones. Iron and link harrows are year by year getting into greater favour. Coleman's and Bentall's scarifier is acknowledged by many as a great boon.

Drills are so much used that we occasionally hear an old-fashioned farmer complain that they have spoiled all the seedsmen, and that it is difficult now to find a carter who knows how to use the seedlip. Drills used to be kept in different districts for hire, but now most of the farmers prefer keeping their own. The waggons are light and well made, and are still used by many in preference to harvest-carts, although these are patronised in different parts of the county, and I believe are gradually increasing in number, more particularly on level farms where the fields are not too far from the homestead: the other carts are heavy and clumsy in the extreme, and call for great improvement. Chaff-cutters are more general than formerly: most people are now persuaded that it is both economical and desirable to cut hay into chaff, apart from the great advantage thus afforded by being enabled to mix together good and inferior hay, with sometimes a portion of oat or barley straw. Turnip-cutters and pulpers are much used; the latter are daily getting

more general for mixing mangold and other roots with chaff for neat cattle and cow-stock.

A few horse-power threshing-machines are to be seen here and there, and occasionally a hand-machine is used by those who have at times a surplus of labour, but I cannot say that they have any other recommendation than that they give employment, in some cases, to those who might otherwise be discharged. The combined steam threshing-machine has become so general as to have nearly silenced the sound of the flail in some parts; however, there are still many practical men who prefer threshing out the greater part of their Lent-corn with the flail; first, because the fodder comes out regularly for the use of the cattle in the yards, and secondly, because there are on most farms some men, with large families, who are glad to do it, as they are thereby enabled to earn a few shillings per week more, which in the winter season is a great help to them. Machines, in some cases, are kept by the farmers for their own use; the engine, when not required for threshing, being used for grinding corn, cutting chaff, bruising, &c.; large farms can employ a 7 or 8 horse-power engine to great advantage in this way, as I have learnt from my own experience. The greater part prefer hiring a machine, many of which are kept for letting out in different parts of the county.

Some only winnow the corn once, and sack it; it is then mixed in a heap and winnowed again before it is sent to market: others finish it at one operation, but this plan is open to objection. A rick is seldom of one uniform quality, consequently a sample taken, to sell by, from any one part is not a fair sample of the whole, and I have heard dealers say they have had more unpleasantness since the introduction of this system than they were ever subjected to before; another objection is that this machine, although cleverly constructed and quite a masterpiece of skill, is nevertheless very complicated, and after it has been in use a considerable time the wear and tear becomes very expensive, from the great number of bearings —something or other is constantly breaking or getting out of order, causing great hindrance from stoppages during the process of threshing. This is now generally performed out of doors, by taking the machine to the ricks, which consequently are made in the fields more frequently than they used to be, by no means to the advantage of the general neat appearance of the county. As the ricks are threshed, the straw is stacked or rather thrown together in a very slovenly way, to be removed again at a convenient season to be made into manure in the yards; there can be no economy in this plan, as straw is never moved so cheaply as it is in the harvest, at which time it should always be taken as

near as possible to the yards where it is likely to be wanted. I do not mean to say that no one is ever justified in stacking in the fields corn grown at a great distance from home if the teams are required elsewhere; but I have often seen this done when sufficient horses were left in the stable to convey it home, with no additional expense except that of an extra boy or two to drive the teams.

The steam-plough has hitherto been but little used, there being only four in different parts of the county, two of Smith's and two of Fowler's; in each instance they have given entire satisfaction, and answered every expectation. From the great number of reports that have been published on the subject, embracing the experience of the occupiers of every description of land, the account of the quantity of work performed, and the proportion of horses dispensed with, it is pretty certain that the steam-plough will ere long be much more extensively used even in this county, where the proportion of strong land, to which it is most applicable, is small, if we compare this with other districts.

Mowing and Reaping Machines.—During the last two summers the mowing-machine has been extensively used on meadow and pasture land, with very satisfactory results; but many farmers object to them for the upland grasses, more particularly the clovers, as they leave the crop spread over the ground, so that it cannot possibly be raked into swathe in such a way as to prevent a large portion of the leaves being lost under the scorching sun of June and July. The reaping-machine has been introduced in several instances, but has not been attended with that success which it has met with in many other counties: this cannot be attributed so much to any defects in the machines as in the parties introducing them. No implement of modern times has so taxed the ingenuity of the manufacturer as this, so that it requires considerable discretion and nicety of adjustment in working it; but these, however, have not been the only difficulties which the reaper has had to overcome. Where it has been purchased solely with a view to saving a trifle in labour, or in order to let the discontented labourers know that the farmer was independent of them, it is not surprising that the result has been altogether unsatisfactory, and that an amount of prejudice has been created which time only can eradicate; but, on the other hand, where it has been employed with the view of benefiting both parties, it has generally been successful, and willing and efficient hands have been found to work it. By using one the last three years, I have been enabled to secure my harvest as quickly as others, and with as little expense, without employing an extra hand. There certainly are crops which a reaping-machine cannot cut to advantage; but by giving the labourers the benefit of it where it can work, they are

quite willing to cut where it cannot, without additional pay: consequently the benefit is mutual. I am therefore disposed to speak very favourably of a machine which enables a farmer to secure his harvest with pleasure to himself and satisfaction to his labourers, and at the same time to be independent of a class of people who one half the year travel about the country earning the money which the regular labourers ought to have the privilege of earning, and who often spend the other half in a very questionable manner.

Labourers' Wages and Condition.

So far as means go, the condition of the labourer may be considered satisfactory; the average weekly pay is 10*s.* to 11*s.*; in the lower part of the county it is rather less, and as we approach nearer to London somewhat higher. Carters and shepherds have 1*s.* per week more than the day-labourer with rent-free cottage and from 2*l.* to 5*l.* as wages, paid at Michaelmas at the termination of a year's service; under carters and shepherds receive from 6*s.* to 8*s.* per week, and from 3*l.* to 6*l.* of yearly wages; plough-boys and shepherd-boys from 3*s.* 6*d.* to 4*s.* 6*d.* per week, and from 1*l.* 10*s.* to 2*l.* 10*s.* wages; the practice of allowing beer is almost discontinued, excepting in the hay-making and harvest, when the men get three or four quarts of ale, and boys two quarts per day. As much of the work as possible is done by the piece:—reaping 10*s.* to 12*s.* per acre, more in some instances for lodged crops; mowing barley and oats 3*s.* 6*d.* to 4*s.* 6*d.*; mowing grass 3*s.* to 4*s.*; flat-hoeing turnips once 5*s.*, twice 9*s.* to 10*s.*; hoeing beans or peas 4*s.* to 6*s.*; threshing barley by flail 1*s.* 8*d.* to 1*s.* 10*d.* per quarter. The following account of the earnings of an ordinary married labourer, with the assistance of his wife, during the wheat and barley harvest, is from the labour-book on a farm in the central district of the county, and may be taken as a fair average:—

1859.	£.	*s.*	*d.*
1st quarter, ending March 25	7	1	8
2nd " June 24	7	9	3
3rd " September 29	15	6	6½
4th " December 31	10	10	9
	40	8	2½

being 15*s.* 6½*d.* per week.

The labourers are generally paid in money every week, many farmers paying on the Friday to give them the opportunity of spending their money on the Saturday to the best advantage: others pay on Saturday, and a few only once a fortnight. Women are seldom seen in the fields during the winter months; but in weeding, hay-making, and harvest-time, they are extensively employed.

The dwellings of the agricultural labourers are good where they are in the hands of the landed proprietors: these have generally three bed-rooms with 30 or 40 poles of ground attached; they are in most cases let at 1*s.* per week. Landlords no longer look upon the cottages as a tax or burden on the estate, but consider them as necessary and important appendages, and in some cases a great ornament. But there are other cottages belonging to different owners in various parts of the county which are only worthy of the name of hovels; and yet are in many cases let at double the price of the former, with barely any garden attached to them. These unfortunately frequently belong to those who take no interest in the moral or social condition of the agricultural labourer; they are, however, gradually decreasing in number every year, and there is good reason to hope that ere long every poor man's home will be such as he can feel a pleasure in returning to after the toils of the day are over, there to spend his leisure hours in a neat and well-kept garden, for the careful cultivation of which there are now many inducements in almost every district—horticultural societies being very general, which give to cottagers prizes for flowers, fruit, vegetables, and the best-cultivated gardens. Garden-allotments do not prevail so much as they did; but adjoining the towns they are still to be seen, and are a great boon to the poorer inhabitants. In the agricultural districts where the gardens are very small, allotments, not exceeding 40 poles each, are sometimes let to the poor by their wealthier neighbours at a moderate price.

The clergy are ever forward in promoting and encouraging every work which has for its object the improvement of the labouring classes. There are but few parishes without coal and clothing clubs, to which the poor contribute a few pence weekly, the subscriptions of the wealthier parishioners being added to their contributions at the end of the year. There are also several excellent Benefit Societies, from which the poor man, by paying a small amount monthly, is provided with medical attendance and from 8*s.* to 12*s.* per week, in case of illness. Where these are unconnected with the public-house they are generally under the management of the clergy, and are patronised by the respectable inhabitants.

Education has advanced with rapid strides during the last ten years. I may say every village has its daily school; in addition to which most clergymen have established night schools, where the working classes have the privilege of attending and improving themselves. These are calculated to produce much good, more particularly to the young men between the ages of 16 and 23, who, from the pernicious system of hiring at statute-fairs, are taken at that age from their homes, and from every one interested

in them, to lodge in hovels and sleep on beds frequently less comfortable than those of the cattle they tend. Thus, unheeded and uncared for, the only wonder is if they do not form vicious and depraved habits, and fall easy victims to vice of all kinds. This is but one of the many evils resulting from these fairs, and I rejoice to see there is a prospect of doing away with them, and that steps have already been taken to that end. In comparing the present with the past, we find, from our gaol statistics, that there is a great diminution of crime, and that our gaols are nearly empty. This may, in a measure, be attributed to the establishment of the County Police-force, which does good service, not so much by the amount of crime which it detects, as that which, either directly or indirectly, it is the means of preventing.

From all these facts, which I have felt it my duty to give, many may infer that the general condition of the labourer is so satisfactory that ere long we may look for extraordinary results. I should be sorry to create such an erroneous impression, and distinctly state that I anticipate nothing of the kind until the moral tone of that class immediately above them has reached a higher standard. Where that bond of sympathy and friendship which should unite the employer and employed does not exist, or only in a very small degree, we often find that farmers do not scruple to discharge their labourers when work is scarce, and they can do without them; and, as a matter of course, in the summer, when the labourers feel that they are of importance to the farmers, they either strike for higher pay or take their labour to a dearer market. Surely remedies may be found for this state of things. In my humble opinion, the first is to provide constant employment for a regular staff of labourers, and, by a judicious introduction of machinery, so to equalise the work on the farm as not to require extra hands in the summer season; next, to let the labourers feel that they are not looked upon as mere machines, who are only valued for the amount of work they can perform, but that they are trusted, treated kindly, helped and respected, in proportion as they help and respect themselves. We shall then find that our interest will be theirs, and that the facilities now afforded them for improvement, decent living, and the formation of industrious habits, will be more appreciated and more productive of good results.

As this is not an essay on agriculture, but a report of facts as they exist, I feel bound, in conclusion, to thank those gentlemen and friends who have so very kindly and readily furnished me with information on the different subjects contained in it, and for the great courtesy I have received from all those whose farms I have inspected. If practice cannot compete with *science*, and I am unsuccessful, it will not be from want of subject-matter, but

from inability on my part to make it worthy of commendation; still I shall not regret having made an attempt, through which I have obtained much valuable information, and have extended and renewed my acquaintance with many of the practical farmers of Berkshire.

Moulsford, Wallingford, Berks.
February 28th, 1860.

II.—*The Mechanical Condition of the Soil favourable for the Growth of Seed.* By Professor Tanner.

Prize Essay.

The cultivator of the soil will find in the preparation of the land for the reception of seed his most laborious duties and those which demand his greatest judgment and skill. When these are accomplished he has, comparatively speaking, little else to do but to commit the seed to the ground, leaving the work he has carried thus far to be completed by the secret operations of Nature, directed by His will who established the law that seed-time and harvest shall not fail.

Plants, having passed through several stages of growth and performed the earlier functions devolving upon them, have the last but most important duty of life reserved for the period of their greatest perfection and beauty. This duty is the formation of seed, endowed with powers capable of reproducing plants similar to those by which the seed has been formed. In the seed we have one of the most interesting examples possible of the wise provision made for the perpetuation of the various forms of vegetation. In it the powers of vegetable life lie dormant until aroused by the conditions favourable for their development, and when these are present the seed forthwith springs into action and growth. In speaking of vegetable life we naturally associate with it the co-operation of some mysterious power, by which the vital energies of the plant are stimulated to action; but although we cannot fully understand the primary principle of life, yet an examination into the changes which take place in the growth of seeds will remove much of the mystery which is often attached to it. To this end, we may take the seed of wheat as a familiar specimen for our examination. It is particularly worthy of notice that the seed consists of two distinct parts —the germ, which is the true seed; and the nourishment stored for the growth of the germ. The position of the germ is indicated by a sear or cicatrix upon the skin, but it is a minute body and forms but a small proportion of the entire seed. It is always

placed adjacent to the bulky portion of the seed, consisting of starch mixed with gluten and albuminous matter, and the whole is enclosed in a coat of dense vegetable matter.

The growth of the seed consists in the development of the germ into a perfect plant, and is known as *germination.* Supposing the conditions of growth to be favourable, the first preliminary is a softening of the coat of the seed, by which means water gains an entrance, and having pervaded the mass causes it to swell freely. When the water reaches the germ of the seed the gluten or albuminous matter near to it undergoes a chemical change, and we have a very important and powerful body formed which is known as diastase. Whether or not the germ in any way participates in this change, we have no proof; but, if not, it is certain that at least by its presence it exerts a controlling power. The same addition of moisture to any other portion of the seed would not produce the same effect, for this agent (diastase) is only found in close proximity to the germ, and its existence in the seed appears to be simultaneous with the first stage of germination. Upon the diastase thus formed devolves the important office of preparing food for the growth of the germ; for the bulk of the seed, although abundant in quantity and exactly suitable in its constituent elements, is not ready for use until it has become soluble in water, and thus been made capable of entering into the circulation of the germ. This is accomplished by means of the diastase, by the agency of which the necessary supplies are prepared, so long as the store of food in the seed is needed. An immediate extension of the cellular matter accompanies the entrance of the food into the circulation, and we have the external evidence of life by the sprouting of the seed. In whatever position the seed may be placed, the radicles at once strike perpendicularly down into the soil, and the tender rootlets fix themselves there with but little delay. As soon as this is effected, the gemmule grows in the opposite direction and becomes developed into the stem and leaves of the plant.

The conditions which control the growth of seeds are, the presence of air, moisture, and warmth; and, to produce healthy germination, all are required in definite proportions. When seed is protected from these agencies it will retain its powers of growth for long periods of time. Thus, wheat, preserved in Egyptian mummies between 3000 and 4000 years, has, after that lapse of time, germinated and produced a large increase. The preservation of the power of growth is entirely dependent upon the seed being kept from those agencies which would excite its vital energy: moisture is the first essential for germination, as it is in consequence of the chemical action excited in the seed by the entrance of water that the seed is aroused to action; and

after this process of growth has been excited, if it become checked, it cannot be renewed. This shows the necessity of keeping seeds dry when they are not required to germinate. Moisture alone is not sufficient for this process of growth, as the seed requires a supply of atmospheric air to enable the necessary chemical changes to proceed. Stagnant water in the soil must of necessity be unfavourable to germination, because it renders the land cold and excludes the free access of air, both of which conditions are prejudicial.

The exceptions to this rule are very few: one, however, may be found amongst agricultural seeds in the floating sweet water-grass (*Glyceria fluitans*), grown in our water-meadows, in which instance immersion in water is absolutely necessary for the growth of the seed. In this case we have a seed which has the power of extracting its supply of air from water,—a power which but very few other seeds possess. The supply of air is as necessary for these aquatic seeds as for any others; for if we drive out the air from water by boiling, they can no longer germinate. For the same reason, seeds which are buried deeply in the earth remain there for many years, not because they want moisture, but because it is unaccompanied by the presence of atmospheric air. The earth raised from wells, or brought from railway cuttings, or ploughed up by a furrow of extra depth, often becomes covered by a growth of vegetation, the produce of seeds which have long been dormant in the soil.

Warmth is another essential condition for germination, which, within moderate limits, is rendered more rapid by an increase of temperature; but it must be accompanied by a proportionate increase of moisture, otherwise it becomes destructive. The action of heat promotes chemical changes in the seed, but a free supply of water is necessary, not only that it may exert a like chemical influence, but also because it enters largely into the more delicate body into which the dry matter of the seed has to be transformed. Thus we see that healthy germination depends upon the combined action of the three agents—heat, water, and air.

The opinions which are entertained respecting the influence of light are conflicting. Some consider that light retards the process of germination, whilst others consider that it does not influence it prejudicially. The experiments which have been made, although far from conclusive, are calculated to favour the former opinion; for the growth, although equally perfect, has not been as rapid under the action of light as when the seed has been covered from it. We know that, as soon as the seed has made sufficient growth to throw out its leaves, the action of light is favourable, its presence enabling the plant to decompose carbonic

acid and to retain the carbon for its own, whilst the oxygen is thrown off into the air. But at this earlier stage of existence, or, in other words, during the period of germination, growth is favoured by an action *just the reverse* of this. The seed and its sprouts want to absorb, not to throw off oxygen, and to emit instead of taking in carbonic acid. During germination, then, the action of light would tend to paralyse the vital powers of the seed, and limit its growth to the hours of darkness, instead of allowing the development to be continuous. Another great advantage gained by covering the seed is the more equable supply of moisture which is preserved beneath the surface, as well as the better opportunity afforded to the roots for firmly fixing themselves in the soil.

After this hasty glance at the general principles involved in the germination of seeds, we may proceed to notice the special requirements of the various crops which come under the care of the agriculturist, and to describe the preparation of the land which is most successfully adopted in each case. It may be as well for me to remark, that although the *composition* of the soil is an essential point in the preparation made for each crop, yet it does not come within the scope of this Essay to notice the means by which we regulate the presence of those fertilisers which are necessary for luxuriant growth.

Wheat.—The mode of preparing land for being sown with wheat will be regulated by the previous cultivation it may have received and the natural character of the soil. The heaviest clay soils are generally prepared by bare fallow: this plan being found, in the majority of cases, productive of the best crops of corn from this description of land. When this plan is properly carried out, the tillage which the field receives brings it into a nice condition for the seed-wheat to make its growth. Close and adhesive as these soils naturally are, it has been found necessary to adopt a method of cultivation by which the character of the soil shall become thoroughly changed. Under the action of a properly-managed fallow the soil becomes broken up by the frosts, baked by the sun's rays, and crumbled again by the fall of rain; and these influences, combined with the inversion and intermixing effected by implements employed upon the land, change it from being close and adhesive in its character into the condition of a well-broken soil fitted for the growth of seed.

There is much difference even amongst heavy clays as to the degree of fineness to which it is desirable to reduce the soil whilst under fallow; but the general feeling is that the soil should not be rolled, so as to bring it into a fine state, unless the land is foul and it is necessary to give the seeds of any weeds which may be in the soil a better opportunity of growth. Even then it is

considered that we run a great risk of getting the soil pasty or muddy when rain falls upon it; and, unless under the circumstances named, it is better to keep the soil in a state of small lumps rather than reduce them into a dusty condition. The same care is necessary in preparing it for the seed-wheat. The last ploughing should leave the land in ridges, and the ploughed earth should not be broken down or crushed until the time of sowing.

An early preparation of these soils is advisable, so that the work may be accomplished whilst the soil can be thrown together in a dry state, after which it may remain untouched until the seed-time. Narrow lands will generally be found best for soils of this class, so that, in carrying out the sowing, the drill and harrows may cover the width between the two furrows, and the horses walk in the furrows, so as not to trample the land. If a fallow has been well managed, so that the land has been thoroughly cleaned from weeds, in case of a wet seed-time, I should have no hesitation in sowing the land broadcast, rather than wait to drill the seed with the risk of injuring the condition of the land and the certainty of delaying the time of sowing.

Clays of this strong character are exceedingly sensitive of moisture. They rapidly absorb it from the air, and when the rain falls, the interstices in the surface soon become closed so as to obstruct its passage. If, whilst the soil is in this soft state, it be pressed, a firm adhesion of the particles takes place. The cups thus formed in the soil by the horses' feet continue to hold water long after the other ground has become dry. The clay soil, which expanded when it absorbed water, is disposed to contract again as it dries, whilst the adhesion formed by pressure still remains. If this adhesion is objectionable to the growth of the seed, as I shall show it to be, it ought to be avoided; and for this reason the sowing of such land should be carried out as early as the climate of the district will permit, and the greatest care should be taken to avoid the injurious influence of treading the soil or pressing it by the use of implements, which may cause its adhesion. Few can at present estimate the full amount of injury occasioned on these soils by the treading of horses on their work,—an injury which probably will only be rightly estimated when we supersede this portion of their labour by steam-cultivation.

After the seed is sown, the harrowing must only be carried out so far as to cover the seed, for the reduction of the surface to a fine tilth is very objectionable; rolling should certainly be avoided. The injurious effect of a fine surface arises from its disposition, in case of violent rain, to form a muddy coating, which, when dry, acts as a crust upon the surface. This covering interrupts the free entrance of the atmospheric air into the

soil, and thereby checks the germination of the seed, and renders it irregular. In the same manner, but in a greater degree, when, by compression, we get an adhesion of the soil, the seed thus enclosed is deprived of the access of air, and cannot make its growth. The stronger and more adhesive the natural character of the clay may be, the greater is the caution necessary to have it well prepared for the seed early in the season, so that it may be sown in good time, and the surface left in a tolerably rough state. These clods of soil will be a good shelter in the winter months, and, by the return of spring, will have mellowed down into a nice mould, valuable to the young plant when the important operation of spring-rolling is carried out; but care must be taken in doing this not to get on to the land too quickly. Now, although I advise that the field be left rough after sowing for the winter months, I must not be supposed to suggest a negligent mode of finishing the work of preparation; for I admire a neatly-finished field of corn, and look upon it as an indication of general good management. The surface may be allowed to remain rough; but, as soon as the implements have finished their work, the labourers should proceed to make clean and sufficient furrows and water-gutters, so as to prevent any lodgment of water upon the surface. This should be done whether the land be underdrained or not. Fertilising as the passage of the water undoubtedly is, I would very much rather not retain it upon the land for this purpose during the winter months.

The next preparation for wheat we have to notice will be upon land which has produced a crop of autumn-feed or early roots—for instance, rape, vetches, cabbage, mangold, potatoes, &c. The soils upon which this system is adopted will be rather lighter than those we have noticed, so that we may describe them as medium clays. These terms are necessarily comparative and also much under the influence of climate; for a clay of medium character in a wet climate will require more careful management than a strong clay in a dry climate, and thus we often find an apparent discrepancy in evidence and opinion, when, in fact, persons are disputing upon circumstances which do not fairly admit of comparison. I have nothing to say here on the question whether for a strong clay a bare fallow is preferable to a crop of autumn-food, or otherwise; I will only observe that the majority of the occupiers of strong clay lands, who argue against bare fallows as unnecessary, live in the drier climates of England, where the difficulties arising in the management of such clay soils, are much reduced. I prefer, however, to take the course of cropping as it may exist, and therefore, without further comment, proceed to notice the preparation of wheat upon clay soils after an autumn green-crop or beans.

As these crops admit of a system of hoeing being carried out, the land will not have much weed upon it when the crop has been removed, but may be supposed to be in good working condition; the early operations may differ according to the nature of the preceding crop, but they again meet when the surface has been cleaned. After beans the land may be better for being skimmed and having the weeds burnt; but, should the ground be too hard for this to be readily done, the use of the plough will be preferable, which should be preceded by forking and picking any couch-grass that may have established itself. The surface should be cleared of any weeds (except annuals) which may be there, and then the more immediate preparation for wheat-sowing will commence.

A single ploughing is enough for getting the land into good order, if summer-tillage has been satisfactorily carried out. The vetches, rape, and part of the cabbage will be generally consumed upon the land, and thus it will often happen that the rain falling upon it will cause the surface to become hardened by the treading of the stock; but if, from this or any other cause, the land is too hard and incapable of being prepared by one ploughing, then a second ploughing must be given, and, if possible, 10 or 14 days should elapse between them, so as to let the soil regain the necessary degree of firmness for the seed.

Wheat, whilst it requires the necessary supplies of air and moisture for its germination, cannot flourish unless it can root firmly, and it is for this reason that, where one ploughing will do, it is always desirable to avoid a second immediately before the sowing.

It is seldom any matter of difficulty, when dealing with clay soils, to secure the necessary degree of firmness, although after vetches the land is sometimes disposed to be puffy in its condition; this is, to a great extent, corrected by the treading of sheep, when the crop is consumed upon the land; but, when one ploughing is enough, the natural cohesion of the soils will generally secure a sufficient firmness in the land.

When wheat has to be sown after an autumn-crop of green food upon light land, the firmness of the soil requires to be carefully attended to. It is generally objectionable for wheat to be sown upon this plan in the southern districts, though in the north of England it is frequently practised, but then measures are adopted to consolidate the land. The crops of autumn-food, which generally precede wheat on light land—viz., rape, turnips and rape, and common turnips—are always consumed upon the land by sheep, and the great point, after ploughing the land, is to follow with a land-presser, and give it time to gain firmness before the wheat is sown; when this firmness cannot be gained naturally,

sheep are often turned upon the field to tread it thoroughly. This, although answering the purpose exceedingly well, cannot be looked upon as a satisfactory plan; but it must be admitted that no rolling produces equal firmness. When this difficulty continues, notwithstanding that the press-roller has been used, and time given to the land to settle, so as to sow upon a stale furrow, the better remedy will often lie in a change of the course of cropping, so as to sow upon a clover-ley, which is decidedly the more frequent and desirable preparation for wheat on these light soils.

There appears to be a strong objection to ley-wheat in some of the northern counties, and, in such cases, the only remedy will be to sow the land whilst it is wet, as this can scarcely fail to give it all the firmness which is required.

The great advantages of clover-ley for wheat consists in the firm furrow which can be turned over when it is ploughed, to promote which object our best ploughs effect the inversion of the furrow, without materially breaking it. Upon clay soils, and even upon strong loamy soils, a careful ploughing of the clover-ley is found to produce a sufficiently firm seed-bed for the wheat, especially when it is allowed to lie for some time to get settled, so that the seed may be sown upon a stale furrow. The use of a share or skimcoulter with the plough, as it assists in burying the turf more completely, is generally desirable, otherwise the clover is apt to spring up between the furrow-slices, which is very objectionable.

As the land gets lighter in its character, the well-known land-presser comes in as a valuable help. These implements are generally made with two pressers, which, following immediately after two ploughs, very completely compress the two furrow-slices turned over, and give the land the required solidity. I have frequently found it an excellent plan to use a small drill in connexion with one of these pressers for sowing clover-ley, when the land is disposed to be rather adhesive in its nature, especially in wet seasons. Such land can often be ploughed up quite dry enough for immediate sowing; but, before a sufficient breadth of it can be prepared for the day's work of a large drill, it gets too wet to be worked, and often has to lie a considerable time before it is again ready for drilling; whereas the use of one of these press-drills admits of the ground being pressed, sown, and harrowed close after the plough, whereby an early and good seed-time is secured.

Another important condition at the time of sowing is the degree of moisture present in the land. Upon clay soils I consider the seed should be sown whilst the land is as dry as possible: it will be sure to receive moisture from the fall of rain, but wetness in the land causes the particles of the soil to

bind together, to the prejudice of the crop. As the soils get lighter there is less objection to working them when wet; in some cases, indeed, this becomes necessary, in order to give them the required firmness. It is not often in the south of England that a wet time is selected for sowing; but, when rain comes on after the work has commenced, I have known it to be continued until the soil was quite muddy, and yet no disadvantage has resulted; on the contrary, the plant has proved firmer on the portion sown wet than upon any other part. This, which may be safe upon one soil, will often be very injurious upon another *apparently* of the same character. Soils which have a sufficient proportion of sand or grit intermixed with them are thus preserved from that adhesion of the particles of the soil which would take place in stronger land, so that, in their case, the germination of the seed is but little delayed, whilst the treading of the land when wet, gives it a greater degree of firmness, and this is favourable to the stability of the plant. The line which appears to separate those soils which are injured from those which are benefited by being worked when moist, is the proportion of sand or grit which the soil contains, and also the condition of the clayey matter with which it is mixed; and this can at present only be safely decided by local experience.

The rules which regulate the quantity of seed-wheat to be sown to the acre are simply these:—the early sowings require less seed, whilst for the later sowings the quantity should be gradually increased; and, again, as the soil and climate become more favourable to the growth of wheat, less seed becomes necessary. The first sowings will take 5 or 6 pecks of seed to the acre, whereas the latest will reach up to 8 pecks, and upon poor land it will range from 7 to 10 pecks: local experience must here also be called in, to decide as to the time of sowing, for it is impossible to lay down any definite rule which can be taken as a safe guide. That comprehensive word climate seems to regulate this point; for neither the character of the soil, proximity to the sea, elevation, nor any other individual influence, decides the practice, but that peculiar knowledge which renders local experience alone worthy of confidence.*

The months of October and November embrace the sowings of our principal wheat-districts, but we must extend our time

* If all that really constitutes climate could be duly taken into account, including excess of dryness on dry soils, of wetness on heavy soils; prolonged exposure to keen winds; alternation of hot days and frosty nights; sudden burst of summer weather, &c., with due allowance for the mechanical defects of the soil, its susceptibility under changes of temperature, and its limited straw-producing power, as well as for possible injury from birds and insects, we might then base our practice on *knowledge* rather than *experience*, but the result would not be successful, if any one element had been overlooked in our calculation.—P. H. F.

from the middle of September to the end of the year to include all the sowings of autumn-wheat. Exposed situations, which require a strong and well-rooted plant to withstand the winter-storms, require an early sowing and a liberal seeding, and so also do soils upon which growth is slow from any other cause. The milder district of the West of England permits the sowing of autumn-wheat to be carried on as late as the end of December, for the almost unchecked growth of the winter enables the plant even then to get quite forward enough for making a good start in the spring.

The influence of soil upon the quantity of seed is accounted for by the fact, that on rich land more stems will be thrown up from each root, than if the soil be poor; and to make up this deficiency, and also to enable the crop more thoroughly to search for nutriment in the land, more plants are necessary; and a larger allowance of seed is the consequence.

The depth most desirable for the germination of seed-wheat depends upon the closeness or adhesive character of the soil. The seed should be placed in that position which will secure to it such a supply of moisture, warmth, and air, as will most rapidly promote healthy germination. It is clear that these conditions cannot be secured in soils of a different texture at one uniform depth.

Upon loamy soils of medium character we find the depth of about 1 inch superior to any other, but as the soil becomes lighter and more sandy in its nature the depth may be advantageously increased to 1½ or 2 inches. In a dry season, a less depth than 1 inch can seldom be looked upon as sufficient to secure to the seed a necessary degree of moisture; and a greater depth than 2 inches is not desirable, because the plant has then generally to raise itself in the soil so that its roots may commence their duties within a moderate distance of the surface. The mode of ploughing in seed-wheat with a 3½ or 4-inch furrow is clearly wrong, for the wheat will not establish its roots in the soil at this depth, and the germination must necessarily be delayed in consequence of this increased depth. If I make any difference in the depth of seed upon soils of this character, I let the early sown wheat be deposited rather deeper than that which may be sown later, and my reason is because the early sowings have plenty of time for making their growth, and, therefore, a full depth insures a firmer root, whereas with late sowings this delay cannot be allowed, for the young wheat will then gain more by appearing more quickly above the ground; but even these variations in depth should not range more than half an inch either way. The lighter the soil becomes, the more important it is to sow at a considerable depth, as this favours the stability of the plant, and

the stronger the land, the greater the necessity for keeping near to the surface.

The three modes of sowing wheat, viz., dibbling, drilling, and sowing broadcast, have each their respective merits and advocates. Dibbling is the system which most perfectly fulfils our ideas of the requirements of vegetable growth; but there are many difficulties in the way of its general adoption, from the large amount of manual labour required, in consequence of the imperfect action of the implements made for this purpose. Drilling is the process which is most extensively adopted, and is decidedly the best and most economical mode of depositing seed-wheat. The great preventive to its more constant adoption is the fact that, as the implement is heavy, tender soils are injured by the traffic over the land in wet seasons, and these soils must have more time given them to become dry and ready for sowing; hence it often becomes desirable, in order that we may avoid a late seed-time, to sow the seed broadcast. The advantages of the drill are very great in the opportunity afforded for hoeing the land, but when the system of horse or hand hoeing is not practised much of the benefit of drilling is lost. After the seed has been sown it should be covered by the use of the harrow, but the less the land is worked the better, and especially upon strong soils. The roughness of the surface will be rather desirable than otherwise, for protecting the wheat-plant during the winter-months.

For sowing spring-wheat the soil need not be brought to as firm a condition as for the autumn sowing, but the difference is only one of degree, and such as enables us at once to see the cause which renders greater solidity essential for autumn sowing.

When wheat is sown upon land which is not sufficiently firm, the plant fails in the severe weather of winter; on the other hand, when the seed has a more solid seed-bed in which to establish itself, the roots are enabled to become more fibrous in form and vigorous in action, and in this manner they obtain a secure hold upon the soil from which the winter frosts cannot dislodge them. The great necessity then for a firm seed-bed for autumn-wheat is to insure the stability of the plant during the winter; consequently there need be no surprise that in spring we are less anxious about our land-pressers.

The preparation of the land in spring for wheat is therefore far less troublesome than in the autumn. After the roots have been removed from or consumed upon the ground, the land is once ploughed and a favourable opportunity taken for sowing it in due course, when the soil is in dry working-order.

A second ploughing is seldom given, for the reasons I assigned when speaking of the autumn-sowing. Early sowing is important for this description of wheat, and as a rule none,

excepting the April wheat, should be sown later than February in the eastern, and March in the western districts of England.

Barley.—The soils in which barley flourishes most luxuriantly are free-working loams, and it is by no means uncommon for such land to be distinguished as barley-land. This preference arises from the natural habit of growth in the barley, which requires a considerable freedom of action for the development of that bunch of fibres of which its root consists. In the preparation of land for its growth this has to be remembered; for, if the character of the soil is not naturally of the description required, we are compelled to adopt measures for rendering it as much so as possible. The firmness which was so necessary for wheat is objectionable here, and the more completely it is destroyed the better.* The course of procedure will depend upon the nature and the quality of the land. It is very seldom that barley is now cultivated except after a root-crop, and I shall presume, therefore, that a root-crop has been consumed upon the land.

Upon the *lightest* class of barley-soils there is great danger of the manure being washed through the soil; on such lands, therefore, the use of the plough is avoided at this time, as the inversion of the soil would favour the loss of manure, and the aid of a cultivator suffices to loosen the soil for the seed-bed. Other soils are brought into a sufficiently loose and free condition for sowing, by means of a single ploughing, but by far the larger breadth of our barley-soils requires further preparation. Soils which have only a moderately adhesive character become considerably hardened by the treading of sheep in feeding-off roots, and the hardness is often much increased by the drying action of the sun and air at the latter end of the season. As soon as the ground is clear of sheep it should be ploughed up, and if in any way disposed to bake it should be either rolled or harrowed immediately afterwards, as the nature of the soil may render most desirable: it should remain in this state until the time for sowing approaches, and then be ploughed a second time. If this does not bring the soil into a sufficiently free working condition the use of the roller and drag will be required. If the second ploughing is preceded by the use of the drag, it will materially favour the work, and this should certainly be done if the soil promises to give trouble, for, in this way, we shall find after the succeeding ploughing that the bottom portion of the surface-soil will have lost much of its firmness.

In this or some similar manner the soil must be reduced to a free working condition ready for the seed, for it is the worst of

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* That is to say, within four or five inches of the surface. According to my experience any loosening of the subsoil by double ploughing on light land, in a dry climate, is prejudicial to the barley crop.—P. H. F.

policy to sow barley upon a badly-worked soil. In the busy time of spring-sowing a farmer is tempted to sow barley quickly and dispense with extra tillage when the soil appears to be in fair condition; but I have often seen that it is unwise to lessen the tillage by being in too much of a hurry, as the superior condition given by a second ploughing and additional tillage makes a very material difference in the crop. The time thus lost in the sowing of the land is soon regained by the more rapid growth of the young plant, which is often observed to maintain the vigour of its early and prosperous career unabated up to the time of harvest.

When a strong loamy soil has to be prepared for barley, especially after it has been hardened by the treading of sheep, we are often obliged to modify our course so as to secure (if possible) the assistance of frost. With this object the land is ploughed up as early as may be after the sheep are removed, and is laid up so as to catch the frost. If the soil gets thoroughly frozen, the after-working of the land becomes comparatively easy, provided reasonable care is taken in selecting the proper time for cross-ploughing and working the land for the seed. The most laborious and difficult preparation for barley is when land of this description is ploughed up in a close condition, so as to be smeared by the mould-board, and, instead of getting any frost upon it afterwards, becomes hardened by exposure. It then requires a vast amount of labour in the shape of rolling, dragging, and ploughing, before it can be reduced to a fair state for sowing, and after all does not afford a satisfactory seed-bed for the barley.

I do not know any kind of corn which suffers so much in its quality as barley, from being sown in an unfavourable seed bed; this is, however, much more evident upon land of a strong and adhesive nature than elsewhere, probably because its mechanical condition is less under our control. The benefit derived from the action of frost enables us to grow, on such soils, barley of fair malting quality; but, if we do not plough in time for the frosts to act upon the land, the produce is rarely fit for the maltster, and can be only employed for feeding purposes.

The best qualities of barley, as well as the largest crops, are produced from soils very free and open in their character, and these indicate the condition to which we should endeavour to bring any soil upon which this crop is to be sown. To promote the same freedom in the soil, the seed should always be sown when the land is dry; for as we have seen in the preparation for wheat, that a wet seed-time was conducive to that increased firmness of the soil which was then our object, so now, when we wish to avoid this effect upon the land, we should in every way avoid the cause.

The use of the drill is very generally preferred for sowing barley to every other mode; and for early sowings on light soil is particularly desirable, because it gives an opportunity for hoeing the ground before the clover-seeds are sown. Upon the stronger description of land a very large proportion is sown broad-cast, because thus there is less compression of the soil, and a larger breadth can be quickly sown, just when the land is in the best condition to receive it. The usual quantity of seed sown is from 2½ to 3 bushels per acre, but upon soils of inferior quality as much as 4 bushels per acre are sometimes used. For late sowings the quantity is increased, because the plants have less time to establish themselves, so as to produce a sufficient plant.

The difference of seasons has a greater influence upon barley than upon any of our corn-crops; for sometimes the early-sown crops are the best, and at other times the last sowing excels all the others. This generally arises from the alterations produced in the mechanical condition of the land. If, for instance, a piece of land has been well prepared for barley and brought to that degree of fineness which is so desirable for it, and after the sowing a long continuance of wet weather sets in, it is more than probable that the soil will run together and form a crust, alike unfavourable to the germination of the seed and the subsequent growth of the plant. On another piece of land of a similar character sown perhaps a month later, but not thus prejudiced by the weather, the seed grows freely, the plant continues to flourish up to the time of the harvest, and produces a decidedly better crop. If this were a constant result the difficulty would easily be overcome by a later sowing, but next season possibly the circumstances may be reversed; dry weather may favour the rapid growth of the early sowings and delay the germination and general development of the late-sown barley. The time of sowing may be stated as including the month of April; in some cases commencing a little earlier, and in others being prolonged beyond that period.

The depth for sowing the seed is not subject to the same variations as in the case of wheat; one inch may be considered sufficient in all soils to secure its healthy germination. The condition in which the land is to be left after the sowing in some measure depends upon the time of performing that operation. When the barley is put in early, the land may be well harrowed and left without rolling; but as the later sowings are generally accompanied by the clover-seed, these are harrowed and rolled to a fine surface. The object in leaving the one unrolled is to prevent the surface from running together after rain. In the latter case there is less risk on this account, as most of the stormy rains of April are by this time passed,

and the more genial weather of May gives less cause for anxiety.

Oats.—This grain is usually sown either after roots or else upon a fresh-broken turf of grass or clover-ley. The natural energy of the root of the oat is much greater than that of barley, so that this plant rather resembles wheat in its powers of penetration. This circumstance has a great influence upon the preparation which is desirable; when oats are to be sown after roots, the ground is usually ploughed once, and time given to the surface to become mellow under the action of frost, before sowing. There is scarcely any difference between preparing grass or ley for oats, the chief modification being earlier ploughing in proportion to the toughness of the turf. An old turf, which must necessarily have got very tough, should be broken up not later than December; whilst a two or three year old clover-ley would not require to be ploughed so early. It must be admitted that early ploughing of the turf is in no way objectionable, and in many respects advantageous, as the vegetable matter becomes rotted by the action of the weather.

In ploughing turf up for oats the skim-coulter should be used, so as to favour the entire covering of the grass; and it is often found that the land-presser is also of service for the more complete laying of the turf, so that the furrow may have a solid bearing with no hollow spaces beneath it. After the turf has been turned over and fairly established, either with or without the aid of the land-presser, the ground may be left until the seed-time comes. During this interval frosts are almost certain to have crumbled the surface and produced a nice light mould for the seed; such land will then present the most desirable seed-bed for oats—a soil well charged with vegetable matter, firm beneath, yet easy of penetration for the rooting of the plant, with a surface light and free in its character for the germination of the seed. This firmness of land for the root must be distinguished from the hardness with which wheat will contend after it has once made a fair growth.

I have known instances in which portions of fields have been so fearfully trodden during the winter (by no means an unusual circumstance in hunting-districts when a large number are in at the death), that all vestige of the wheat-plant has been destroyed, and yet at the following harvest the crop on such portions has been very superior. This the oat could not stand against, for, whilst it requires a firm soil, it cannot flourish in a hard soil. Nothing suits the oat better than a turf ploughed down; and, conversely, as a general rule there is nothing preferable to the oat for strong turf. In the north of England where the turf even of a clover-ley becomes too rank for wheat, the oat comes in as

the substitute; and cases are very rare in which either wheat or barley can displace the oat from old and rich turf newly ploughed up. I do not here include clover-leys and such artificial grass-turf, but I think, with these exceptions, there is no corn-crop which will penetrate and break up an old turf as well as the oat; the reason is because turf presents just that condition of soil which meets the requirements of its roots, and, if the seed requires a light covering, this is generally produced by an exposure of the soil to frost and a light tillage of the land. To favour this result the turf should be ploughed whilst moderately moist, but the surface should not be broken down for sowing until it is in dry working order; the same degree of moisture which favours the solidity of the turf, would, if the surface be cultivated at the same time, render it close and adhesive and quite unfavourable to the germination of the seed.

The sowing of oats commences in February, and in some of the midland districts as early as January, but the great bulk is sown in March. There is a very general feeling in favour of early sowing, and the practice is certainly altering in that direction. When oats are sown upon turf, it becomes much more necessary to sow early, than when they follow a root-crop or bastard fallow. The great objection is the influence of frost, which frequently gives a bluish tint to the blade, but, if the land is in fair condition, will not materially injure the crop. A larger proportion of oats than of any other grain is sown broad-cast, chiefly because an earlier seed-time can thus be secured. It often happens that the ground will harrow well when it is not dry enough for drilling; and in wet districts, with the uncertainty of spring weather, waiting for the drill frequently involves a considerable loss of time, and thus much is sown broad-cast even where the drill would in some respects be preferable.

Upon land which is foul, and especially on old grass-land, it is very important to drill the seed, as we thus secure an opportunity for destroying the weeds, which would otherwise materially injure the crop. After the seed is sown, the land should be well harrowed so as to cover the seed thoroughly. The use of the roller depends much on circumstances; if the ground has been ploughed late and is not in a favourable condition, the roller will be employed to reduce it to a fine tilth, but this will precede the sowing. As a general rule (and especially in the case of early sowings), the ground is better not rolled down smooth after the seed is deposited, but should be left rough from the harrow. This roughness will be attended with a double advantage; for it will protect the plant from the severity of the cold winds, and, by the time these are past and the oats are ready for rolling, these rough portions of the soil will be nicely mellowed, so that the crop will then be

improved by the fresh soil as well as by the pressure. Upon some of our blowing sands this roughness of the surface is the chief protection to the crop. I have known the greater portion of a crop of oats blown off the ground, simply from the field having been rolled instead of being left rough from the harrow. Upon such land the seed must always be buried deeply, say two inches, for this gives the plant a better opportunity for securing itself to the spot.

The quantity of seed will vary according to local requirements, but the variable character of the seed-oat in a great measure explains the difference in the quantity sown. As the oat degenerates in character, so it becomes longer and less plump than good seed; for this reason, inferior seed weighs less, and numbers less to the bushel, than a sample of close and sound seed. Thus, whilst some use from ten pecks to three bushels, according to the time of sowing, others put on from four to five bushels of seed-oats to the acre. This difference cannot, however, be entirely traced to one cause; for when the climate is wet, and there is a great tendency to produce straw, a thick seeding favours the yield of corn.

Peas.—The cultivation of peas is seldom practised as part of any regular rotation of crops, and they must rather be considered as a catch crop. The preparation will necessarily vary in detail according to the preceding crop. A corn-stubble is more generally selected for this purpose, but a young clover-ley, on which the plant has partially failed, is by no means unfrequently used. The system of cultivation generally approved commences with cleaning the surface of the land in the autumn of the year, after which the farm-yard manure (if any is to be applied) is spread upon the land and ploughed in before winter. In this state it remains until the arrival of the seed-time in the spring. If the land during this interval has become close and adhesive, it receives another ploughing in the spring, immediately before the sowing of the seed; but this only becomes necessary in the stronger class of soils, upon which peas are not so frequently grown. The pea requires a free and loose soil for its successful growth, and it is upon soils of this character that it is chiefly cultivated. The land can scarcely be rendered too free for their growth, and hence soils which do not need to be ploughed a second time are improved by the use of the cultivator in the spring, unless the manure is thus brought to the surface, in which case a drag will be preferable. The seed-bed best suited for peas may therefore be described as a deeply-worked and well-cultivated soil, fine in texture, loose and free; the seed should therefore be sown when it is dry, so as not to prejudice the condition of the land.

The depth at which the seed should be sown will vary from two

to three inches, according to the time of sowing and the nature of the land; the earliest sowings and the lightest lands having the seed deposited at the greater depth. Drilling is, beyond question, the best mode of depositing the seed so as to allow of cultivation between the rows during growth. The plan of double rows, nine or ten inches apart, with an interval of 18 or 20 inches between them, is advisable because of the greater facility for cleaning the land and the greater support which the peas gain from the neighbouring row. Three bushels of seed to the acre is the usual quantity sown. The early sowings may be commenced in February upon dry and light soils, and be continued up to the middle or end of March, by which time the seed should all be in the ground.

Beans.—This crop requires a soil of strong and adhesive character, as much for the supplies of food which it requires, as for the mechanical qualities which such land offers to the plant. In this last respect, beans do not differ materially from wheat; for a firm condition of the land appears in each case to be equally necessary, and our preparation for this crop is regulated accordingly. Beans are almost always sown upon a corn-stubble, and even in exceptional cases the treatment adopted is directed to the attainment of the same condition of soil. The practice of different districts necessarily varies much in detail, but the following system is that which is generally adopted, and may be taken as illustrative of the most suitable kind of management. The stubble should be cleaned in the autumn as well as circumstances will allow; the manure should then be spread upon the land, and the land ploughed up deeply and laid as rough as possible for the winter: in this state it lies until the seed-time has arrived. But some prefer to reserve the manure until it can be applied in a well-rotted state early in the spring, and then plough it in; but this does not suit the crop as well as the earlier use already described, especially on true bean-land. If the dung is ploughed in before winter, the land has time to become sufficiently settled before the time for sowing, whilst the manure below prevents it from becoming too consolidated for the plant to make a vigorous growth.

The bean flourishes best in a deep but strong soil, and the penetrating powers of its root are well adapted for extending into and through a firm soil; hence the great importance of the cultivated soil being well settled before the seed is deposited. This is secured by the early ploughing of the land, whilst the exposure of the surface makes it free and easily worked and secures a light covering for the seed, open to the influences of air and heat. When the land is not prepared before winter, we often find the seed ploughed in without the furrow-slice being broken. Four bushels is an average allowance

of seed for the drill, and the beans are thus deposited about three inches from the surface.

The practice of dibbling the seed is quite as general as the employment of the drill, and it has many advantages: one of these (besides the saving of seed), is the earlier sowing which it enables us to make upon the strong land ploughed up before winter; for such ground will often admit of hand-labour of this kind when it would suffer much from the working of a drill. Beans are dibbled and drilled at various widths from 9 to 27 inches, but I prefer double rows at the distance of 6 or 8 inches, with 20 or 24 inch intervals. This width between the rows is especially important if we consider the bean crop (as we ought) to be a fallow-crop. When the seed is sown, nothing more is required but to cover the seed, either by hand or by harrow; but after the beans are well above the ground the roller is serviceable, as it consolidates the soil and prepares the bean for an early commencement of the blossoming. This may be advantageously followed by the use of the horse-hoe and stirrers in the intervals, when the beans have sufficiently firm hold upon the land which is immediately beneath them. The time of sowing beans extends throughout February and March, but, as far as climate will allow, an early preparation, followed by an early sowing, will produce the most satisfactory results.

In the growth of winter beans the same objects should be aimed at. The ploughing of the land should be finished by the middle of September, and a month allowed for the ground to settle. The seed should be drilled as near the middle of October as possible, after due care has been taken to get the ground firm. It is want of firmness in the soil, and late sowing of winter-beans, that have prejudiced the minds of many against their more extended growth. A firm seed-bed is as important for the stability of the bean as we have seen it to be for the wheat crop, but this point is frequently overlooked. In sowing this variety of bean, the wider intervals are eventually necessary for the purpose of horse-hoeing.

Grass and Clover Seeds.—Under this head we may include both natural and artificial grasses. These seeds are small in size, and proportionately weak in their powers of growth; for which reason they require the greater care to secure their healthy germination. A depth and condition of soil which may be suitable for larger and more vigorous seeds is really destructive to their growth. Some experiments which have been reported* on the germination of seeds are so satisfactory and conclusive that I

* Morton's 'Encyclopedia of Agriculture,' vol. i. p. 999.

have introduced them here as they furnish us with decided evidence respecting the growth of seeds under highly favourable circumstances.

Column No. 1 shows the depths at which the largest number of seeds grew.

Column No. 2 shows the depths at which one-half of the seeds grew.

Column No. 3 shows the least depth at which none grew.

Botanical Names.	Trivial Names.	No. 1.	No. 2.	No. 3.
		Inch.	Inch.	Inch.
Agrostis stolonifera ..	Fiorin-grass	0 to $\frac{1}{4}$	$\frac{1}{2}$ to $\frac{3}{4}$	1
Aira cæspitosa	Hair-grass	0 to $\frac{1}{2}$	$\frac{3}{4}$ to 1	$2\frac{1}{4}$
Alopecurus pratensis ..	Meadow foxtail-grass ..	0 to $\frac{1}{2}$	1 to $1\frac{1}{4}$	$2\frac{1}{4}$
Anthoxanthum odoratum	Sweet-scented vernal-grass	0 to $\frac{1}{2}$	1 to $1\frac{1}{4}$	2
Arrhenatherum avenaceum	Common oatlike-grass ..	$\frac{1}{2}$ to $\frac{3}{4}$	$1\frac{1}{2}$ to $1\frac{3}{4}$	4
Brachypodium sylvaticum	Wood fescue-grass	0 to $\frac{1}{4}$	$\frac{1}{2}$ to $\frac{3}{4}$	2
Dactylis glomerata	Cocksfoot-grass	0 to $\frac{1}{4}$	$\frac{3}{4}$ to 1	$2\frac{1}{4}$
Elymus arenarius	Sea-sand lyme-grass	1 to $1\frac{1}{2}$	2 to $2\frac{1}{2}$	5
Festuca duriuscula	Hard fescue-grass	0 to $\frac{1}{4}$	$\frac{3}{4}$ to 1	$2\frac{1}{4}$
„ elatior	Tall meadow-grass	0 to $\frac{1}{4}$	1 to $1\frac{1}{4}$	$2\frac{3}{4}$
„ elatior, gigantea	Gigantic meadow-fescue ..	0 to $\frac{1}{4}$	$1\frac{1}{4}$ to $1\frac{1}{2}$	3
„ heterophylla ..	Various-leaved hard-fescue	0 to $\frac{1}{4}$	1 to $1\frac{1}{4}$	$2\frac{1}{4}$
„ ovina	Sheep's-fescue	0 to $\frac{1}{4}$	$\frac{3}{4}$ to 1	2
„ pratensis	Meadow-fescue	0 to $\frac{1}{2}$	$\frac{3}{4}$ to 1	$2\frac{1}{2}$
Glyceria aquatica	Reedy sweet water-grass ..	$\frac{1}{4}$ to $\frac{1}{2}$	$\frac{3}{4}$ to 1	$2\frac{1}{4}$
Holcus lanatus	Soft meadow-grass	$\frac{1}{4}$ to $\frac{1}{2}$	$\frac{3}{4}$ to 1	$2\frac{1}{2}$
Lolium italicum	Italian rye-grass	0 to $\frac{1}{4}$	1 to $1\frac{1}{4}$	$3\frac{1}{4}$
„ perenne	Perennial rye-grass	$\frac{1}{4}$ to $\frac{1}{2}$	$1\frac{1}{2}$ to $1\frac{3}{4}$	$3\frac{1}{2}$
Phleum pratense	Meadow cat's-tail	0 to $\frac{1}{4}$	$\frac{3}{4}$ to 1	2
Poa nemoralis, sempervirens	Evergreen wood meadow-grass	0 to $\frac{1}{4}$	$\frac{1}{4}$ to $\frac{1}{2}$	1
„ trivialis	Rough-stalked meadow-grass	0 to $\frac{1}{4}$	$\frac{1}{2}$ to $\frac{3}{4}$	$1\frac{1}{2}$
Psamma arundinacea ..	Sand-reed	$\frac{1}{2}$ to 1	$1\frac{1}{2}$ to $1\frac{3}{4}$	4
Achillea millefolium ..	Yarrow	$\frac{1}{4}$ to $\frac{1}{2}$	$\frac{1}{2}$ to $\frac{3}{4}$	$1\frac{1}{2}$
Lotus corniculatus	Bird's-foot trefoil	0 to $\frac{1}{4}$	$\frac{1}{4}$ to $\frac{1}{2}$	$1\frac{1}{2}$
Medicago lupulina	Black medic or nonsuch ..	0 to $\frac{1}{4}$	$\frac{3}{4}$ to 1	$1\frac{1}{2}$
Ornobrychio sativa	Saintfoin	$\frac{3}{4}$ to 1	2 to $2\frac{1}{4}$	$4\frac{1}{4}$
Plantago lanceolata	Rib-grass	$\frac{1}{4}$ to $\frac{1}{2}$	$1\frac{1}{4}$ to $1\frac{1}{2}$	$2\frac{1}{2}$
Poterium sanguisorba ..	Common salad-burnet ..	$\frac{1}{2}$ to $\frac{3}{4}$	$1\frac{1}{2}$ to $1\frac{3}{4}$	4
Trifolium filiforme	Trefoil	0 to $\frac{1}{4}$	$\frac{1}{4}$ to $\frac{1}{2}$	$1\frac{1}{4}$
„ hybridum ..	Alsike clover	0 to $\frac{1}{4}$	$\frac{1}{2}$ to $\frac{3}{4}$	$1\frac{1}{4}$
„ pratense	Common red clover	0 to $\frac{1}{2}$	$1\frac{1}{4}$ to $1\frac{1}{2}$	2
„ pratense perenne	Cow-grass	0 to $\frac{1}{2}$	$1\frac{1}{4}$ to $1\frac{1}{2}$	2
„ repens	White clover	0 to $\frac{1}{4}$	$\frac{1}{2}$ to $\frac{3}{4}$	$1\frac{1}{2}$

The inference which may be fairly drawn from these results is, that seeds of this class should be laid as near the surface as possible, so that the covering of the soil shall be of the thinnest character. A slight covering, however, is desirable for the purpose of retaining moisture; for seed placed upon the surface is naturally subject to the drying influence of the air, which, after germination has commenced, may so check the growth as to prove destructive to its existence. In field-culture

we cannot rely upon the germination of seeds which are uncovered, because we cannot regulate the supply of moisture; still we see that the depth of the covering has an important influence on the thickness of the plant, and must shape our proceedings accordingly. This explains the variations in the success attendant upon different modes of preparing for grass-seeds.

As these seeds are usually sown with a corn-crop, the early preparation of the ground is carried on without regard to their special requirements. They are sometimes sown immediately after the corn is in the ground and the land has been well harrowed; but, unless in the case of a late sowing, this plan is objectionable, because they then sprout and show their tender leaves above the ground too soon, being exposed to injury by the cold nights at the end of April and beginning of May; also because the ground is then in too loose a condition to secure the seed from sinking too deeply into the soil. If the soil has been worked to a very fine condition and is then rolled, the seed may be sown without much loss, a cross-rolling being sufficient to cover it when sown. This extra rolling, however, in case of much rain, might be very prejudicial to the growth of the seed-corn. As a general rule, it will be far better for the grass-seeds to be sown after the corn is well rooted in the ground; the soil will then become settled, and there will be less disposition to allow these small seeds to sink between the particles of the soil beyond the proper depth. The benefit of a slight covering in a great measure explains the greater thickness of the clover-plant when sown upon barley-land which has received *extra* tillage, and has thus been brought to a fine tilth, for the seed thus sown is well placed for immediate growth.

If the surface is at all crusted over, a very light harrowing should first be given; after this the seed may be sown and then rolled down. Should the surface be free and slightly rough, so as to crumble readily beneath the pressure of the foot, the seed may be sown without previous working and then rolled in: but in case the surface is judged to be too rough for this treatment, it must be rolled lightly, harrowed if necessary, and again rolled after the seeds are sown. A careful use of the roller is generally the best means for covering the seeds, but it must always be done whilst the ground is dry and works freely. Another great advantage gained by sowing after the corn is up, is the shelter and protection given to the seeds and also to the young plants. A moderate degree of firmness in the soil beneath the seed is not objectionable, as the roots are powerful in piercing the soil, and a sufficient degree of freedom is usually possessed by land sown with spring-corn.

Turnips and Swedes.—Various as is the practice of different

districts in preparing land for these crops, still all agree as to the condition of soil to be attained. These crops flourish on deep and free soils, and especially the turnip, which is far less calculated for strong land than the swede. Upon soils which are naturally strong and adhesive, by good cultivation and manure luxuriant crops are grown ; but the great point still to be secured is that fineness and looseness in the condition of the soil which enables the roots of the plants to gather nourishment and make their growth. By ploughing the stronger class of soils before winter, and by active tillage in the spring of the year, these necessary conditions are secured, and thus the tenacious and adhesive qualities of many soils are for a time, at least, changed, and deep tilth is secured, well adapted for the extension of the roots in search of food and moisture. The lighter class of soils are brought into a proper mechanical condition with much less difficulty, so that, instead of the preparation having to be commenced before winter, it is often found desirable to grow a crop of spring-feed upon the land, in the expectation that after it has been consumed, one or two ploughings will prove sufficient to prepare for the turnip-crop. It is by no means uncommon for the land to be prepared as if for being sown, fourteen or eighteen days in advance. The land in such cases is harrowed down fine and left in this condition, so that the seeds of any weeds may make a growth, which will be destroyed when the surface is moved in the sowing of the turnip-seed.

Respecting the cleanness of the land and its friable condition as a preparation for these crops, there will be scarcely any difference of opinion ; but as regards the moisture of the land there will be considerable diversity observable : whilst some cultivators endeavour to get their soils as dry as possible, others regulate their proceedings so as best to preserve the moisture in the soil. Thus, in the practice just mentioned of working the land fine and leaving it undisturbed for a time, so that the seeds of weeds may sprout, some would plough the land up and let it dry for the reception of the seed, whilst others will be equally particular not to move it farther than by harrowing the surface, for fear of drying it.

It is not only in this particular instance that there is such contradictory practice, but it pervades all the preparation immediately preceding the sowing of the seed. I have had a fair share of experience in the growth of turnips and swedes, and have always found the dry seed-bed to be decidedly preferable. The cause is not difficult of explanation. When seed is deposited in a soil which has been properly cultivated and there is a moderate degree of moisture, it speedily germinates. The hot weather which we are accustomed to have at this time causes a rapid

growth, and the young plant quickly appears above the surface; but the warmth which has thus far been productive of apparently good results has probably by this time robbed the soil of so much of its moisture that the supplies to the plant decrease at the most critical time of its existence, and unless rain falls the crop is lost; or if the turnip-beetle should commence an attack there is but little hope of the plant gaining the mastery. The case is very different when the seed is deposited in a dry soil: there it lies uninjured, waiting for rain, and does not begin to germinate until it gets it. The rains in June generally afford a tolerably liberal allowance of water when they do come, quite sufficient to carry the seed well through its first stages of growth, until it has a rough leaf and a strong root. The delay is immaterial as regards time, but not so as regards the safety of the crop. If the seed does germinate during those intervals of dry weather, *its existence is really dependent upon a timely supply of rain;* but so long as growth has not commenced no fear need be entertained for the crop. Dryness at the time of sowing becomes of greater importance as the land gets lighter in its nature and more easily dried by the heat of the sun.

The quantity of seed sown to the acre varies from 2 to 6 lbs., according to circumstances. One very frequent cause of failure is mixed seed, of which only a portion will grow. This is easily detected by growing a given number of seeds in a pan. When the seed is of good quality, an allowance of 4 lbs. per acre is ample, but not excessive; indeed, I consider that the risks which the plant runs in its early days render a decrease in the quantity of seed very poor economy, and this becomes evident when we consider how large an outlay is dependent upon the safety of the plant. A liberal supply of good seed gives a far better chance for some to escape the turnip-beetle, because, unless it is a very wet season, it is more than probable that the seed will not all germinate at one time, and for this reason patience often does as much good as a second sowing of seed.

The drill is the best implement for turnip-sowing, and if artificial manure is applied at the same time, as is very desirable, the arrangement of our best drills for getting a layer of earth between the seed and manure is very important.

The ravages of the turnip-beetle render dibbling quite unsafe. The seed grows most satisfactorily when deposited about half or three-quarters of an inch beneath the surface: this is shallow enough for a safe growth without causing any unnecessary delay. After the seed has been sown, harrowing once is sufficient to leave the land in proper order, but rolling should in general be avoided. There is a greater variety of opinion as to the time of sowing swedes than any other root-crop. Early sowing,

which is favourable—I might say, essential—for some districts, is altogether unsuited to others. Thus, from early in May to the middle of July, swedes are being sown according to local opinions. The principal cause of this is the mildew, which the swedes suffer from if their growth experiences a sudden check; but, whilst local peculiarities do exist and exert their influence upon the time of sowing, yet I am bound to say that as the system of cultivation is improved and the land is more thoroughly worked, the sowings may be made at an earlier date with far greater safety.

Mangold-Wurzel.—This root is better adapted for strong soils than the swede, and possesses greater powers of growth through a retentive soil than any of our root-crops. The looseness and friability of soil, which were necessary for the turnip and swede, are not necessary in this case except in a very reduced degree, and for this reason a course of preparation answers very well for the mangold which would not do for any other root. There are two modes of preparing for this crop. The one is a complete autumn preparation, so that the dung is ploughed in and the land ridged-up for the seed before winter, whilst the other leaves the application of the manure and the tillage of the land to be finished in the spring. Each of these plans has its respective advantages.

The autumn preparation influences the mechanical condition of the land by exposing the surface of the land to the winter frosts, whereby it is crumbled into a fine and loose seed-bed, whilst the manure beneath prevents the soil from becoming too consolidated, with the additional advantage that you are ready to sow in good time, and can ensure that the land shall be in good condition for the seed even when other ground cannot be touched. The surface-soil, which the winter has brought into such good order, generally retains its character, unless it is worked by some implement which smears and glazes the surface, but this must be carefully avoided. This autumn preparation is easily completed in unfavourable seasons by dibbling the seed by hand. If the spring weather is unpropitious, there is great difficulty in then completing the necessary preparations for sowing in good season, and especially in securing a nice fine covering for the seed, which is not the less essential, because at a later stage the roots luxuriate in a strong soil, such as cannot always be brought to a fine tilth by spring culture. On such soils this is often a great difficulty.

Early sowing is of great importance for this crop. The usual season is from the middle of April to the middle of May, and for the heavy crops we must not trust to late sowings. The growth of the seed may be promoted by steeping it in water for a few hours before it is planted. This will soften the skin and render germination more rapid. After this has

been done, it should be kept moist until it be placed in the soil, and then be lightly covered by fine soil to the depth of from half to three-quarters of an inch. It is usual to run a light roller over the surface after the seed is sown, unless the soil is too moist to allow it to be done. The best mode of sowing the seed is by means of the hand-dibble, especially in the case of strong land, upon which it often enables an early sowing to be secured, when waiting for the drill would have made it late.

Carrots and Parsnips.—A deeply-cultivated soil is necessary for each of these roots, but they differ in the soils for which they are best adapted. The carrot flourishes best in a very loose and friable soil : the parsnip prefers stronger land, and can be successfully grown on soils which are too stiff for carrots. The best mode of cultivating them is after another root-crop, as they require the land to be kept very free from weeds during their growth. When they follow a corn-crop particular care must be taken to have the land well cleaned in the autumn, and ploughed (if possible subsoiled also) before the winter. Thus the labour in the spring will be brought within moderate limits for securing that condition of soil which these crops require, viz., a deep and thoroughly-cultivated soil, with a fine surface; when this has been obtained we may consider that we have completed the necessary preparation.

Carrots should be sown early in April, and the parsnips early in March; for producing heavy crops the seeds must be sown in good time. The progress of the parsnip and carrot may be much favoured by mixing the seed with some damp sand a few days before it is to be sown, and laying it out shallow in a warm room. When this is not done, the carrot-seeds need other preparation, because they cling together so much; a good rubbing between the hands, followed by the admixture of as much as three bushels of ashes to the acre, is probably the best means for favouring its distribution on the land. When this precaution is taken, the seed can be very easily drilled, and this is by far the more frequent mode of sowing both these crops; but many prefer sowing both carrots and parsnips by hand, especially after germination has been encouraged. It is a very good plan to mix some corn with the seed, so as to indicate its position for the early guidance of the horse-hoe.

The seed is usually sown in drills, from 12 to 18 inches apart; and about 6 lbs. of seed per acre gives a sufficiently thick plant. It should not be buried more than three-quarters of an inch from the surface. When the sowing is completed, the land should be lightly harrowed, if corn has been mixed with the seed, but otherwise it will be better to roll the ground, so as not to destroy the drill-marks; but, if the land be at all adhesive, a light harrowing is preferable

Rape or Cole.—The general requirements of this crop are similar to those of the turnip, and need not be repeated; but I may add to former remarks that the peculiar characteristics of some of our soils which are favourable for growth of rape, but not of turnips, arise from their composition rather than from their mechanical condition. The preparation necessary in each case is the same; but the time of sowing extends from April to September, according to the succession of food which may be required. The rapidity of growth varies much with the climate, richness of the land, and method of cultivation; but the sowings in April and May will generally be ready for feeding in August and sometimes in July, whilst the August and September sowings come in for spring use. As the principal demand for rape is in September and October, the corresponding seed-time is June and July; still the influence of climate will often render the growth slower, and necessitate an earlier sowing. From 2 to 4 quarts of seed per acre will be necessary, according to the suitability of the soil and climate, care being always taken to increase the allowance of seed as circumstances become unfavourable.

Spring-feed.—The crops which are usually sown for this purpose (with one exception, which I shall subsequently notice) all require a similar preparation to be given to the land for the reception of the seed, however varied may be the soils for which they are in a special degree adapted, and however this character of the soil and the succession of food required may influence the choice of the crop. They are sown upon the corn-stubble, and the class of soils selected for their growth are generally dry and free in their nature. Their growth upon strong soils is exceptional, and never to be recommended except in dry climates. After the corn is cut the cleaning of the surface should immediately commence, and, as soon as this is done, the land should be deeply ploughed, (for we have to prepare for the succeeding root-crop as well as for the present one); after it has lain a few days the sowing of the earliest spring-feed may take place. Nothing further, besides rolling, will be required before the seed is sown, for these soils are not difficult of cultivation. Rye is one of the earliest crops for spring-food, and usually forms the first sowing. It is generally sown broadcast, at the rate of 4 bushels to the acre. The next sowing will be rye and vetches, or else winter-oats and vetches mixed. For these the same preparation will be necessary. The usual allowance is 1 bushel of rye or oats and 3 bushels of vetches per acre, either sown broadcast or by the drill: thick sowing is always advisable for spring-crops. For these crops rather stronger land may be selected than for the rye, and they are also more likely to receive manure, as they require more nourishment from the land, and, if so, the roller will be necessary.

The sowings will be commenced in September, and continued at intervals to the end of October. Vetches may be sown about the middle of October, without any mixture; but they will not be ready for use as quickly as the mixed seeds. In these cases rolling will be found advisable, especially when the soil is not covered with a fine mould, which is very necessary for the growth of these seeds. It is also desirable, after the use of the drag, to give some pressure to the soil, as they do not thrive well when the ground is too loose; with rye this is not so material as with vetches. A dry time should be selected for sowing the seed, and after this the land should be left harrowed and not rolled.

French Clover or Trifolium.—This plant is somewhat peculiar from the excessive firmness of soil required for its successful growth. It is usually sown after a corn-crop, and, for its culture, a clean stubble should be selected upon land which is tolerably stiff. If this is twice harrowed it will produce soil enough to cover the seed, and this seems to be all that is requisite except a light rolling. This may appear to be a slovenly mode of farming; but it is decidedly the best plan, for, when the stubble is pared and the land cleaned, and especially if it should be ploughed, the trifolium will not thrive so well. As regards the appearance of the stubble, provided a clean stubble be chosen, no doubt need be entertained that successful practice will justify from every charge of neglect, when in the spring the stubble disappears amidst the luxuriant growth of the clover. About 20 lbs. sown broadcast will be found a sufficient quantity of seed to the acre. When the soil has been loosened more than by moderate harrowing, the roller must precede the sowing, otherwise much of it will run down into the soil too deeply for germination, and a thin plant will be the consequence.

I have thus noticed the special requirements of each of our principal agricultural crops, so far as regards the mechanical condition of the land, and other circumstances connected with the successful germination of seed. So far as my limits have allowed me, I have endeavoured to show the chief variations in practice; but it must be remarked that local peculiarities of soil and climate will occasion exceptions from these general rules in minor points of management, which are still of the greatest importance for obtaining a successful growth. I do not, therefore, pretend to say that the conditions named will be *invariably* applicable; but, from a rather extended experience, I have reason to consider that they represent the most successful systems of management.

Queen's College, Birmingham.

III.—*Essay on Recent Improvements in Dairy Practice.* By James Fulton.

Prize Essay.

In no branch of our rural economy would theoretical knowledge be of more service than in the dairy, yet dairy practice is perhaps less enlightened by science or aided by scientific appliances than any other. The art of cheesemaking, as is well known, has for a long period remained stationary, if it has not retrograded. When an empirical process, devoid of any guiding principle, is handed down from one generation to another, what other result can be looked for? It is the opinion of many, and records furnish strong evidence in its favour, that English cheese of the present day is inferior in quality to that which was made centuries ago.

It is gratifying, however, to observe that this important branch has at length partaken of the spirit of the age, and that through the efforts of several ingenious and public-spirited individuals, some valuable chemical and mechanical improvements, calculated to improve the quality and increase the quantity of our produce, have recently been introduced. Amongst these the following deserves particular notice:—An apparatus, invented and patented by Mr. Richard Keevil, of Stroud Farm, Laycock, near Chippenham, for cutting, filtering, and pressing the curd. One of these was presented to the Bakewell Farmers' Club by Sir Joseph Paxton, with a view to its being put into the hands of the members for trial. It was entrusted to the care of Mr. Gregory, of Meadow Place, who reported favourably to the Club, and subsequently furnished a fuller statement to the maker in a letter of which the following is a copy:—

"Meadow Place Farm, Bakewell, Derbyshire,
"July 18, 1856.

"Gentlemen,—I have much pleasure in handing you a copy of my report upon the trial made with Keevil's patent cheese-making apparatus. I should have sent you this report sooner, but the result of the first trial so surprised me, and the increased weight of curd making the cheese a larger size than suits this market, I determined to make a second trial before doing so.

"I now send you the results of both trials, and must say they have fully satisfied me of the great advantage to be gained by the use of this apparatus. Besides the increased weight of curd produced, there is a great amount of arduous and unpleasant labour saved, the process being rendered much easier and more cleanly. I have bored two of the first cheeses I made by the apparatus, and find them much firmer than any others made in the usual manner, although they are four or five weeks older.

"I am, Gentlemen, yours very truly,

"Thomas Gregory.

"*Messrs. T. F. Griffiths.*

"June 19.—100 gallons of milk made in the usual manner 89½ lbs. of cheese, being weighed when taken out of salt eight days after making.

"June 20.—100 gallons of milk made in Keevil's apparatus 100 lbs. of cheese, being weighed when taken out of salt eight days after making—showing an increase of 12 per cent.

"July 2.—90 gallons of milk made in Keevil's apparatus 95 lbs. of cheese, being weighed when taken out of salt eight days after making—showing an increase of 16 per cent."

Mr. J. Singleton has likewise furnished the following account of his experience, in a letter addressed to the maker:—

"St. Michael's on Wyre, near Garstang, Lancashire,
"October 28, 1856.

"Gentlemen,—Having had Keevil's patent cheese-making apparatus on trial for the time agreed upon, I now, in accordance with my promise, hand you particulars of our experiments. To prove what were the real advantages of the apparatus (as you suggested), we made the cheese alternately in the patent machine one day and in our old utensils the other, measuring every day's milk, and weighing the cheese when taken out of salt. During my experiments we have made up 848 gallons of milk in Keevil's apparatus, producing 1039 lbs. of cheese, and by our former method 632 gallons of milk, making 734½ lbs. of cheese—thus showing an increase of 6¼ lbs. on each 100 gallons of milk; and I feel bound to state that the increase was gained against the most strenuous (and I think laudable) efforts to make our old way prove the most productive. Besides the increase of weight, which in a dairy of thirty cows in the summer season would amount to about 35 lbs. per week, worth 19*s.*, I consider there is an improvement in quality on the whole quantity of fully 2*s.* 6*d.* per cwt., or ¼*d.* per lb., amounting on the total week's make of say 460 lbs., to the further sum of about 9*s.* 6*d.*, making together 28*s.* 6*d.* per week increase in value on the produce of thirty cows. There is also a great saving of time effected and much dirty and slopping work entirely avoided, as well as the necessity for employing much skilled labour.

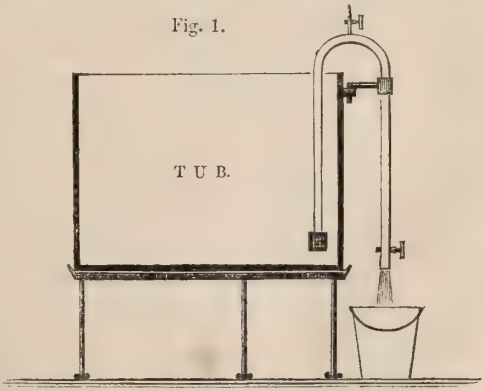
"I am, Gentlemen, yours truly,
"John Singleton.

"*Messrs. Griffiths and Co.*"

It would appear from the above reports that this apparatus has effected a considerable advance in dairy practice. The cutting department of it in particular, which consists of a revolving frame, filled with thin sharp knives about an inch apart, is a valuable improvement. The breaking of the curd by the means hitherto in use is very imperfectly performed; for while one part is insufficiently broken, the other is literally bruised and churned, which causes much of the fat and caseine to be separated and carried off in the form of white whey. These evils are entirely obviated by the use of Keevil's revolving knives, which, passing gently through the curd, divide it in such a clean and even manner as to ensure a regular and perfect separation of the whey, which comes away, as it ought, quite thin and clear. The revolving knives, or breaker, however, which may be used in any tub, constitute the principal improvements in Keevil's apparatus; the pressing and filtering departments of it—the one for

separating, the other for drawing off, the whey—may be an advance on former methods, but they are now superseded by other improvements. The whey can be separated by a more scientific mode, practised in Somersetshire and the neighbouring counties where Cheddar cheese is made. This is effected by the natural contraction and precipitation of the curd, under the chemical action of heat applied in heated whey. In about an hour from the first breaking up of the coagulum, a quantity of whey is drawn off into a pan and placed in a boiler containing boiling water. While this is being heated, the curd is again broken into minute pieces, preparatory to the introduction of the whey, which is heated to 140°, and as much of it is returned to the mass as will raise its temperature to 100°. During the pouring in of the whey—which should not be rapid—the mass is kept in motion with an agitator (which may consist of a piece of board or white tin, placed on the face of the revolving knives), to prevent any portion of the curd from being over-heated. When the mass is brought to the proper temperature, as determined by the thermometer, the motion is continued with the agitator more slowly for twenty or thirty minutes, or until the curd acquire a proper degree of consistency, which is indicated by a certain elastic granular feeling, on its being grasped in the palm of the hand. The agitator is then withdrawn, and the mass allowed to settle. In a short time the curd falls to the bottom, almost entirely separated from the whey, without pressure or mechanical force, which is not employed or required until the last stage of the process, when the curd is made up in the cheese-vat.* By separating the whey in this way more curd, as determined by experiment, is obtained, than when mechanical force is used; and as the Cheddar is the highest-priced English cheese (Stilton excepted), it may be inferred that the quality is also improved. This improved process, technically termed slip-scalding, is due to Mr. Joseph Harding, Marksbury, near Bristol, and some others.

Fig. 1.



The introduction of the use of the syphon (Fig. 1) for drawing the whey off the curd,

* See Prize Report on making Cheddar Cheese, 'Transactions of the Highland and Agricultural Society,' 1st July, 1859.

has of late superseded the filtering part of Keevil's apparatus. This implement consists of a bent white iron tube, one inch in diameter, one leg being 18 inches long and the other 21 inches. These dimensions are large enough for a tub of about two feet deep. A filter made of brass wiregauze is applied to the end of the shorter leg, while a stop-cock is tached to that of the longer. The syphon, on the top of which is fixed a small gas-cock, for drawing off the air, is affixed to the tub by means of a clasp, that admits of being put off and on without the least trouble. The filter-end is immersed in the whey, which it draws off with the greatest ease and convenience when the syphon is in good working order. When the whey is nearly exhausted, the side of the tub opposite to the syphon is a little raised. The spigot in the bottom of the tub is then withdrawn, to drain off the whey remaining about the curd. The merits of this invention are that it acts without in the least disturbing the curd in drawing off the whey, which flows from a point near to the bottom of the tub, so that the fat floating on the surface of the whey is not removed, but settles down upon the curd.*

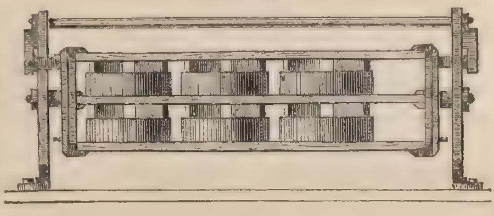
I may also notice a greatly-improved coagulating-tub, brought out last year at my suggestion. It is constructed of white iron, with double sides and bottom, for the purpose of holding hot or cold water for regulating the temperature. The inside bottom is made convex to facilitate the discharge of the whey through a spigot-hole; there is an opening at the top into the space between, for receiving the water, and a stop-cock or crane at the bottom for its discharge. The tub is set on an iron frame with three legs about 10 or 12 inches high. The one special advantage of this utensil, which every experienced dairy manager will appreciate, is the control which it gives over the temperature of the milk and curd. Every dairymaid knows the difficulties experienced from the cooling of the milk when coagulation is not effected with the first application of rennet; and will recognise the advantage of being able to reduce the temperature of the evening's milk when put into the tub in sultry weather by filling the space with cold water, or, on the other hand, to raise it in the morning by the application of hot water. Again, when the milk is set with the rennet the vacuum checks the radiation of heat, and, therefore, makes the mass cool less quickly, whilst by pouring in a little hot water, which will surround the mass with warm vapour, the original temperature can not only be maintained, but may be raised. This invention, therefore, enables us to carry out an important prin-

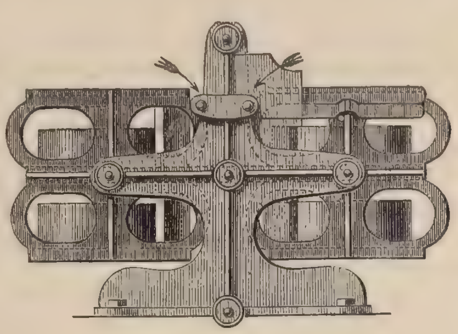
* This syphon, designed and introduced by the author, is made by James Lyon, 60, St. George's Road, Glasgow, price 7s.

ciple in the manufacture of cheese, viz., that the temperature, instead of being allowed to fall from the time of setting the milk with the rennet, should be gradually raised to a higher range, until the curd has lost its affinity for the whey and subsided to the bottom of the tub.*

A cheese-press (fig. 2) of ingenious construction and great power: a stove connected with warm water-pipes for heating the cheese-room, and a cheese turner, registered by John Strutt, Esq., of Belper, near Derby, may also be noticed as recent improvements.

Fig. 2.





The next, and perhaps the most interesting of recent inventions for advancing dairy practice, is an acetometer for testing and regulating the chemical condition of the milk when it is set with the rennet at the commencement of the process, and for ascertaining the progress of *acidification*, so as to enable the dairymaid to perform the subsequent operations at the proper moment.

Cheesemaking being a process of lactic fermentation, at every stage of which certain products are developed, it is evident that it cannot, without an instrument of this kind, be conducted either with chemical precision or with uniform results. A thermometer to regulate the temperature is all that was once thought necessary; but when the art of cheesemaking is farther advanced, it will be found that the temperature of the milk ought to be subordinate to, and regulated by its chemical condition.

The acetometer in question was invented and introduced last year by the writer, who, in two publications, drew public attention to the usefulness of such a test, and was the first to recognise and

* This improved tub is made by James Lyon, 60, St. George's Road, Glasgow; price, with frame for twenty cows' milk, 4*l*. 10*s*.

point out the importance of regulating the chemical condition of the milk when the rennet is added, and the influence which the state of *alkalinity* or acidity, under which it is coagulated, has on the quality and quantity of the cheese.

In the making of butter the acetometer will be found to be of equal utility; for as acidity is in some respects equivalent to an increase of temperature, the latter ought to be regulated by the degree to which the former is developed. When the cream has attained a high degree of acidity the temperature should be proportionally lower, and *vice versâ.* It is because the influence of the chemical condition of the cream was not recognised, that no uniform or trustworthy results were ever obtained from experiments in churning.

A short description of the principle and construction of this acetometer will suffice to render it intelligible. Simplicity and accuracy being the properties aimed at, a saturated solution of lime-water is the alkali adopted. This can be made by any dairymaid, and has this additional advantage, that its gravity is little affected by variations in the temperature; since no calculations or reference to tables are required, this test may be comprehended and applied by any intelligent girl of twelve years of age.

The instruments consist of a jar, containing a certain measure when full up to a given mark, and of a tube, of the same capacity, graduated into 100 parts. When the milk or whey is to be tested, the measure-glass is filled up to the mark, and the tube filled with the stock solution of lime-water; as much of the latter is poured into the measure-glass amongst the milk, whey, or cream as will neutralise its acidity, as indicated by litmus-paper. Thus every part of lime-water poured from the tube represents one per cent. of acidity.*

The introduction of this chemical instrument is among the earliest attempts to unite practice with science in the dairy, and may be regarded as marking a new era in the history of the manufacture of butter and cheese.

In connexion with the improvement last noticed, a table, framed by the writer, for the register of observations, was lately introduced, and has, during the last two years, been in use in several dairies in the kingdom. Where this record is used, each cheese is impressed with characters made of wood or brass wire, indicating the month and day of the month corresponding to the entry in the table; so that, by turning to the register, reference can be made at any future time to the conditions under

* The glasses for Fulton's acetometer were made by Mr. Twaddle, price about 6*s.* 6*d.*

which each cheese was prepared. The value of such a register, not only for the private convenience of the owner, but also as an aid to the collection of statistical information of practical and scientific interest, need not be enlarged upon. Rennet, acidity, and temperature are the agents which govern the changes which the milk undergoes in the hands of the dairymaid, yet little is known of the effect which different degrees and proportions of these agents exert on the quantity and quality of the produce. Without observation and experiment there can be no progress, but even experiments can be of little service unless the conditions under which they were made are correctly and carefully recorded. Is it, therefore, unreasonable to hope that the use of this table will not only be a means of eliciting new facts calculated to improve the manufacture of cheese, but also of exciting an intelligent interest in the minds of those who are entrusted with the work?

The foregoing, with a few others which hardly call for a special notice, complete the list of improvements in dairy practice known to the writer, who has devoted much time and attention to the advancement of this interesting branch of rural industry.

To sum up, then, by way of recapitulation. If the recent inventions and discoveries were all in operation in one dairy, there would be, taking them in the order of the process—

First. The coagulating-tub (Fig. 3, p. 80), with double sides and bottom, and intervening space for regulating the temperature.

Secondly. The revolving knives (Fig. 4, p. 80), placed in a frame; the one half perpendicular, the other horizontal.

Thirdly. The use of chemical means instead of mechanical force for the separation of the whey.

Fourthly. The curd-mill), with round instead of sharp or cutting teeth; by which change a closer texture in the cheese is gained.

Fifthly. The cheese-presses referred to.

Sixthly. The stove or hot-water pipes, for supplying heat in the cheese-room.

Seventhly. The registered cheese-turning machine.

Eighthly. The acetometer and the other chemical instruments referred to, viz. a thermometer adapted for curd as well as milk or cream, and an apparatus for filtering rennet.

Lastly. There is the register table, a copy of which will be found annexed.

Independently of these improvements, which show a great advance on the dairy practice of former times, perhaps the most important of all is the spirit of emulation and inquiry recently awakened through the efforts of the press, which has rendered good service to its brother of the dairy, and which, if judiciously

SPECIMEN TABLE FOR THE REGISTER

Date of Observation.	Number of Cows.	Quantity of Milk.	Cream kept off.	Temperature of Milk when Rennet is put in.	Percentage of Cream.	Chemical State of the Milk when Rennet is added.			Degree of Acidity.	State of the Rennet.				Time occupied in Coagulation.		Temperature of Curd when Broken up.	Temperature to which the Curd is afterwards raised by Hot Whey.	Temperature of Curd when Pressure is applied.
1857.		Gals.	Gills.	Deg.		Alkaline.	Neutral.	Acid.	Deg.	Fresh.	Stale.	Clear.	Turbid	H.	M.	Deg.	Deg.	Deg.
May 1																		
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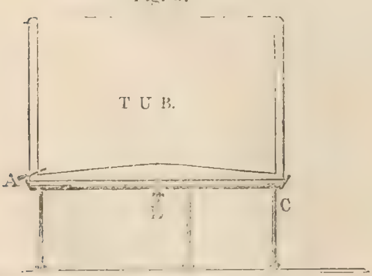
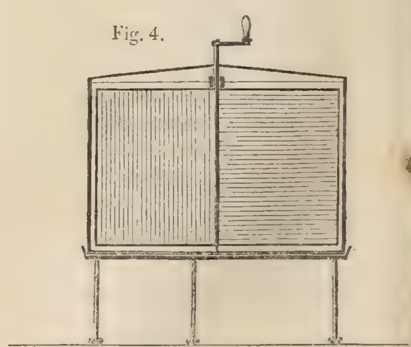
Fig. 3.



A. Spigot. B. Crane. C. Frame.

Fig. 4.



OF OBSERVATIONS IN THE DAIRY.

Interval betwixt the breaking of Curd and the forming of the Cheese.		Weight of Curd when stoned.	Curd left over.	Curd added.	Quantity of Salt in Curd.	Quantity of Salt in Milk.	Quantity of Whey.	Quantity of Fleetings.	Quantity of Whey Butter.	Heat of Dairy Room.			Time occupied in stoning the Cheese.	Weight of Cheese at subsequent periods.			Temperature of Cheese Room at 8 o'clock A.M.	GENERAL REMARKS.
										7 o'clock	11 o'clock	4 o'clock						
H.	M.	Lbs.	Lbs.	Lbs.	Oz.	Oz.	Gals.	Gills.	Lbs.	Deg.	Deg.	Deg.	Days.	Lbs.	Lbs.	Lbs.	Deg.	

judiciously encouraged and directed, cannot fail to raise dairy practice from an empirical process to a scientific art.*

Temple Marghill, near Glasgow.

* Besides the implements and apparatus referred to in this Essay, I am informed that the following are worthy of notice:—Travis's patent cheesemaking apparatus, for cutting, soaking, and pressing curd, and taking off whey by pipe or valve: price for 36 gallons, 9*l.*; 65 gallons, 12*l.*; 80 gallons, 15*l.* 10*s.*; 100 gallons, 16*l.* 10*s.*; 120 gallons, 17*l.* 10*s.* Corne's registered cheesemaking apparatus, for filtering the whey from the curd. This apparatus is mounted on wheels, and can be moved to any part of the dairy for convenience. MacAdam's patent whey-separator, for removing the whey from the cheese-tub without the labour of lifting. It can be fitted to any tub: price, with flexible tube, 2*l.*; with telescope-tubes, 2*l.* 10*s.* A curd-mill, price 2*l.* 5*s.*, made by Messrs. Young, Vulcan Foundry, Ayr. Single and double cheese-presses, prices 2*l.* 10*s.*, and 4*l.* 15*s.*, also by Messrs. Young. A thermometer, adapted for curd as well as milk, price 5*s.*, made by W. Twaddle, Glasgow.—P. H. F.

IV.—*Recent Improvements in Dairy Practice.* By JOSEPH HARDING.

THE spirit of improvement which has so largely pervaded the agricultural world during the last twenty-five or thirty years is not more manifest in the production of corn and meat than it is in the manufacture of butter and cheese; and though the latter branch has not derived as much benefit from the assistance of national or local agricultural societies as the former, it has yet made great progress both as to the quantity and the quality of its products. To the attainment of this object nearly every well-informed and intelligent dairy-farmer has contributed his part. In detailing these improvements I may not, perhaps, be expected to go into all the dairy districts of England, and to particularise every improvement which has taken place in each of them; my experience, as a Somersetshire man, milking a dairy of my own of from 70 to 75 cows, will enable me to speak from personal and practical knowledge as to the improvements, in all their details, in the dairy practice of my own county, more especially in the manufacture of cheese.

I believe, however, from the knowledge which I have of other dairy districts, such as Gloucester, Wilts, Leicester, Derby, and Cheshire, that any disinterested person taking upon himself to write upon the subject could not fix on a district better calculated to answer the requirements of the Royal Agricultural Society of England than the county of Somerset. It is true that this county is not much noted for its butter; but as a district for making cheese, due regard being had both to quantity and quality, it is not surpassed in Great Britain. Here is made what is termed the "Cheddar cheese," which is always quoted in the London market at a higher price than any other (Stilton excepted, which is not a fair example). Here, too, an example has been set in the improvement of machinery, utensils, and mode of manufacture, which has given a stimulus not only to all the surrounding districts, but even to Scotland.*

But my business is not so much to eulogise the dairy practice and produce of this or any other district, as to detail, in a simple and intelligible manner, any improvements which have tended to increase the quantity, improve the quality of these products, and at the same time to reduce the labour of manufacture.

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* See a pamphlet published by the Deputation sent by the Ayrshire Agricultural Association to the various cheese-making districts in England, to ascertain the best and most remunerative method of cheese-making, and reprinted in the Journal of the Bath and West of England Society, 1857.

Increase in Quantity.

In order to show an increase in the dairy produce of any given district, it would be necessary to know its aggregate amount at different periods; but as, to the best of my knowledge, no records exist which furnish this information as derived from any dairy district in England, it will be impossible to contrast our present average produce with that of former years. The only course, therefore, which we can adopt is to take a single farm which may be considered a fair specimen of the district in which it is situated. A farm of 150 acres in this county, of fair quality, divided into 110 acres of pasture and 40 of arable, would, some years ago, probably have been stocked with 30 cows, 5 or 6 heifers (to keep up the stock), besides a few horses. The arable course would have been 1 fallow, 2 wheat, 3 beans, 4 wheat again, 5 clover mown twice, then fallow again; barley being grown occasionally on suitable soil.* It was thought that on the pasture-land no more cows could be kept than the one-half would maintain in summer, the other half being mown for winter-keep; that would give (allowing 3 acres per cow) 90 acres for 30 cows, and 20 acres would be left for the young stock and horses. The arable land at this time received the greater part, if not all, the manure.

A farm of this description would now keep 50 cows. The larger part of the arable land would be in grass and roots, corn being grown only on the decay of the grass plant, which, instead of being mown would be grazed by the cows, and admit of being stocked a fortnight earlier in spring than the meadow-grass: the straw would be cut into chaff and mixed with roots, meal, oil-cake, or some other substitute to make it equal in nutriment to hay. The roots would be chiefly grown by artificial manures, and a portion of them fed off by dry sheep, so that a considerable part of the yard manure could be spared for the pasture-land. Although I have spoken above only of an increase of 20 cows, I know some farms on which the extra number is even larger.

Where the farm is wholly pasture, as is the case with a large number of the dairy-farms in this county, there cannot be as large an increase of produce as is stated above. Yet even here, as the land is made to carry as much stock as possible, the increase in the number kept is considerable. Some farmers will feed nearly all their land and sell the cows in the autumn, looking forward to replacing them in the spring of the year. This seems to be an expensive mode of increasing dairy produce; but where

* Clover is not so much sown on dairy-farms as it would be if it could be safely fed by cows.

the land produces a large quantity of milk the grass is of far more value than the hay.

Others, again, have adopted the plan of preserving a few acres of aftermath (after being fed once) till the spring; the young grass is thus drawn up by the shelter which the old affords, and consequently comes to feed earlier than it would otherwise do. This feed is valuable for turning out the cows by day; it thus both lessens the consumption of hay and increases the yield of milk. Among my acquaintance the farmer who realises the largest amount of profit per cow, lives in Leicestershire, and makes both butter and cheese. His farm is a loamy soil, not much affected by drought or wet, so that it is generally in a growing state throughout the summer. He keeps only cows and young stock. The cows have the first feed of every field, the heifers following them in the round of the farm. A man brings up the rear to clean up the droppings, so that the field is clean and fresh for the cows on their next round.

The building of houses and yards for the accommodation of the cow has not a little tended to an increase of produce, inasmuch as it has enabled us to keep the stock off the land during the winter months. The grass consequently grows earlier in the spring, and enables us to mow earlier, so as to secure a better feed on the aftergrass. The introduction of artificial manures has rendered us great assistance, especially for the arable lands, although the pasture likewise feels the effects of the change. Bones have been used on the pasture, but not to such an extent nor with such success as in Cheshire. Besides all this, nearly all the wet lands have been drained, and the wide and useless hedgerows grubbed up, so that our atmosphere has become dryer and more healthy. Nature has lent a helping hand, and we have in consequence a longer summer and a shorter winter. A large quantity of cheese is made from some of the hills which formerly only fed a few half-starved sheep and cattle. Some of these improvements may seem to be of small importance to the casual reader; but when carried out through a whole district, as in this county, the effect is great, and these, I believe, are the chief causes which have led to the dairy produce of this county being increased, within a few years, 25 per cent.

Reduction of Labour in the Manufacture.

Under this head, speaking first of butter, I may state that the improvements are not so great either in the mode of making, the utensils employed, or the reduction of labour, as in the case of cheese, because two very simple processes only are required to accomplish the object, namely, "churning" and "working." Churning is a simple process of agitation, and whether it be

accomplished by a vertical, a longitudinal, or a rotatory motion, the effect is the same; and notwithstanding the many attempted improvements in the construction of the utensil employed, there is not for general purposes, anything superior to, or that is likely to supersede, the old barrel-churn. In it, either a large or a small quantity of butter, and that of the best quality, may be produced.

As to the working the butter—which is generally performed by the hand—the object is the extraction of all the buttermilk. Some persons use small wooden spades, others envelope their hands in a cloth, but nothing of this kind can be termed a "late improvement." The greatest step in advance consists in the fact that observation and the introduction of the thermometer has enabled us to lay down a rule for the temperature to be maintained in churning. It is found that if the cream be put into the churn at from 55° to 60° in summer and not less than 60° in the winter, it will be churned in good time, that is, from half an hour to forty minutes, and, if properly worked, will produce good butter. If it be churned at a lower temperature it will be too long in churning, and will require heating during the process. If above that temperature, it will "come" too soon and will be frothy and oily; in both cases the butter will be inferior. Until a comparatively recent date, it was a difficulty in cold weather to get the butter churned; the process not unfrequently occupied several hours, and I have known the produce to be thrown away as utterly useless after all. This difficulty is now entirely overcome.

Experience, moreover, has taught us that although, if milk be allowed to stand till it becomes stale or sour before the cream is removed from it, the butter thus made will not be good; on the other hand, if the cream be taken while the milk is sweet, the cream may be kept until it becomes sour, without the butter being materially affected.

The process of butter-making varies in different countries. In Scotland, Ireland, and Wales they churn the milk, and, when this is done properly, I believe that the butter, for delicacy of flavour, cannot be surpassed.

In the making of cheese a much greater improvement has been effected, in consequence of its having received more attention than butter-making, cheese being the staple commodity of the district, and, when well made, more remunerative to the farmer. For many years past it has been our object to produce the *best cheese* with the *least possible labour*,—an object we have, in no small degree, accomplished. Within my own recollection, a week, at the least, may be said to have been occupied in making a cheese,—that is, from the time the milk was coagulated till the cheese was taken from the press to the cheese-room. During this time it was turned in the press twice every day, and had salt

rubbed over it by the hand every morning. I have known, in a dairy of 50 cows, 52 cheeses to be thus turned twice a-day, giving a vast amount of unnecessary labour to the dairy-woman and expense for cloths to the farmer. This state of things exists to this day in some of our largest cheesemaking districts.

The machinery and utensils, too, were of a rude description. The presses were either a large stone raised by a screw, or a box filled with some heavy material and suspended between two upright posts and lowered or raised by ropes and pulleys. I should have thought it almost incredible that there should exist a cheesemaking district in England that had not partaken of the universal improvement in the cheese-press, had I not learnt a lesson the other day. A friend of mine was travelling in a railway carriage in Lancashire in which some farmers were discussing the merits of an improved cheese-press lately introduced into their district, when one of them, convinced of its superiority, said, "I do not think I shall lay out much money in a stone-press again."

The utensils were generally made of wood, and the whey, however large the quantity, had to be ladled out of the tub with a heavy wooden bowl. The curd, when put into the vat, was broken into small pieces by the hand, so laborious a work that I have seen dairy-women whose finger-joints were grown large and stiff in consequence. After the cheeses were introduced to the cheese-room, they had to be washed and scraped before they became marketable, which was not generally the case until they were from four to six months old, although they were what we should now term *thin cheese*. In many instances the cheese was kept until the following spring. The process of manufacture was unsystematic and irregular, without regard to an even or proper temperature; consequently the cheese was of unequal quality—some good, some bad—from causes unknown to the dairy-women. This was the state of things when improvement in the machinery and utensils began to be studied. It is just, however, to state that, with regard to the cheese-tub, a few wealthy and enterprising men thought it desirable to substitute copper in lieu of wood many years before this general movement took place. These tubs were made rough and at a great expense, many of them costing from 40*l.* to 60*l.* apiece, according to the number of cows kept.

About thirty years ago the first improved cheese-press was exhibited in Wells market, in this county, and, though extremely simple, proved to be a step in the right direction. I think that prizes have been awarded to it in its incomplete shape more than once by the Royal and other Agricultural Societies. The principle of its construction was that of the lever in its simplest form. The subject was immediately taken up by the mechanics

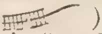
of the neighbourhood, who gradually improved upon the cheese-press until the model now in general use was produced. It consists of a screw and lever, the former working in a brass socket, and serving as a fulcrum * for the latter, by which the pressure, produced and regulated by a weight attached to the opposite end of the lever, is conveyed to the cheese. When the screw is reversed the lever drops on to a pin, the pressure is withdrawn, and the cheese may be removed. This is decidedly the best implement for the purpose that has yet been invented. It is manufactured in large numbers by the best agricultural implement makers in this and the adjoining counties.

About this time copper, and sometimes brass, began to be used more frequently for making cheese-tubs, but, being too expensive for general use, tin was successfully substituted and continues to be employed to the present time. It costs one-third the price of copper, and will last for twenty or thirty years. All the other utensils of the dairy which were formerly of wood, such as bowls, pails, &c., are now made of tin, which saves a vast amount of labour and expense in brushes.

The vessels are in some cases improved in shape as well as in material; the cheese-tub, which was flat at the bottom, is now made convex to facilitate draining off the whey. A large brass tap is soldered into the bottom of the tub, inside of which is a strainer made of fine gauze, wire, or other material, to prevent small particles of curd from escaping. The whey flowing from this tap is conveyed in a pipe leading from the floor of the dairy to a tank or cistern in the piggery, from whence it is pumped for use. That the milkers may not enter the dairy, a tin receiver is placed outside the house, into which the milk is poured and conveyed to the cheese-tub by a conduit, at each end of which is a strainer to prevent any filth from the yard from passing into the cheese-tub. It is a mistaken notion with many practical cheesemakers, and all theorists, that an exceedingly fine strainer is necessary in order to separate the whey from the curd. If the cheese be well made, the curd itself is the best strainer or filterer; but where there is a large bulk of whey to be drawn off from the curd, it will flow through the tap with great force, so as to carry away particles of curd, if something is not placed inside as a strainer. To obviate this, a new and valuable instrument, called the Whey Separator, has just been invented by Mr. Robert McAdam, of Garsty Hill, near Crewe, Cheshire, for which he has taken out a patent. It is made of brass, and is a telescopic tube, one end of which fits on inside the outlet in the bottom of the tub; to the other end is screwed a receiver, which floats on the surface of the whey, which enters

* See illustration, p. 92.

its perforated brass under-surface, and is thus conveyed down the tube to the brass tap at the bottom of the tub, the tubes sinking into each other as the whey subsides. This separator costs about 40*s.*; it is the best thing of the kind I have ever seen, as it takes the whey from the surface, where it is most free from curd, and prevents the mass of the curd from being disturbed by the whey on its passage to the outlet.

The curd-breaker generally in use for breaking up the coagulated mass is either the shovel-breaker or the revolving-breaker. The former is made of wood in the shape of a shovel with a bent handle (); through the lower end of the handle, at right angles to it, 9 or 10 brass rods are inserted, extending about 6 in. on either side, and secured at each end by a strip of wood about 14 inches in length. The revolver is made of rods of iron, set in a framework fitted to the inside of the tub, where it is made to revolve upon a vertical axis by a handle at the outside of the tub like that of a churn.

The vats, which were formerly made of turned wood, are now made of staves like a cask. In not a few instances tin is employed for the purpose, but I scarcely think it will come into general use for our thick cheeses. The stave-vat has recently been improved by being made to open at the side at one of the joints between the staves, corresponding to opposite joints across the top and the bottom; the opening is sufficiently wide to allow of the cheese being easily liberated from the vat when reversed for the purpose. To accomplish this, there are four projecting screw-holes: one at each end of the two severed iron hoops which encircle the vat, one at the top and one at the bottom. When the vat is closed, two of these screw-holes will be opposite each other, and through them a screw-bolt is inserted which keeps the vat together; by loosening these bolts the vat is enabled to expand and the cheese is easily liberated.*

An apparatus has been invented for cheese-making by Mr. Keevil, of Wiltshire, and is in use in that and some other districts, which, though not applicable to the Somerset or Cheddar mode of making, is, I believe, of service in making the Wiltshire cheese. It consists of a tin tub, down the side of which there runs a strip of gauze wire, 3 or 4 inches in width, which allows the whey to escape to a brass tap at the bottom. A breaker is used, similar to the revolver above described, but Mr. Keevil has altered the round rod to a flat knife-shaped piece of iron, thus altering the principle of *breaking* the mass to that of *cutting*. Instead of a vat into which weights were put for the purpose of pressing the curd in the tub, a perforated circular piece of tin is

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* See illustration, p. 92.

used, fitting the inside of the tub, to which pressure is applied by a screw running through a strong cross-piece of iron, fastened to the opposite sides of the tub. The cheese-tub is on a raised platform, and can be made to incline at pleasure, so as to allow the last drop of whey to escape.

A much more useful apparatus for our improved method of cheesemaking has been invented by Messrs. Cockey and Son, of Frome. Its object is to save the labour of carrying the milk to and from the boiler for heating previous to the introduction of the rennet, and also of carrying the whey for scalding the curd. A small boiler is placed in a desirable situation, from which hot water is conveyed by pipes to a chamber underneath the tub, where it can be turned off or on at pleasure by stop-cocks. One advantage in this apparatus is, that during the summer nights cold water may be let into the chamber underneath the evening's milk, which is thus rapidly cooled down to the temperature of the water. This expedient is very valuable for keeping the milk sweet till the morning, as we make cheese only once a day. The apparatus is extensively used in this and some other counties. During the winter months the cheese-room and dairy are heated from the same boiler.

The Improvement in the Quality of Cheese

is due partly to what is here technically called "*slip-scalding*" and to increased attention bestowed on the manufacture, and partly to more careful storing in the cheese-room. In all these cases the thermometer and the clock have greatly assisted in reducing cheesemaking to a regular system. The process is now conducted in the following manner. The morning's milk is mixed with the evening's at a temperature of about 80° (varying 2° or 3° in the spring and autumn), the rennet then is added, and an hour is allowed for the curd to form, when it is carefully broken up; and here commences the system of *slip-scalding*, now generally adopted in preference to the old method. The scalding whey is now added to the curd in its pulpy state, before it has had time to subside and get hard. Experience has shown us that a finer description of cheese is produced upon this principle, which is adopted by the best cheesemakers in this county. What is here called *scalding* is the raising the mass of curd and whey to the temperature of 100° Fahr. By Cockey's apparatus, hot water is introduced into the chamber by pipes placed underneath the tub to accomplish this purpose; otherwise, hot whey is poured into the mass, which in both cases is being well stirred, until the desired heat is obtained. The curd is then allowed to subside, and, after the whey is drained off and the curd becomes dry, instead of being broken by the hand, it is passed through the

curd-mill, after which salt is added and mixed with it in the proportion of 1 lb. to 56 lbs. It is then put into the vat and press, where it remains three days, after which it is taken to the cheese-room. The cheeses are made from 9 to 14 inches in thickness, some even more. They are only turned twice in the press, and that is when the cloths are changed.

The method of keeping the cheese in the cheese-room has also been improved.

At one time we thought it desirable to keep them in a low and even damp temperature, but the cheese was then a long time in getting ripe, and a fine mellow flavour was not readily obtained. We now introduce them at once from the press to the cheese-room, which is kept at a temperature of from 50° to 70°, as the case may be; and we find that the cheese ripens faster, acquires a richer flavour, and can be sold much sooner; so that our thick cheeses are often cut over the counter at three months old, sometimes even less; though a few years since the same sized cheese would have required eight or nine months to acquire the same degree of ripeness.

This system of making has diminished the make of whey butter. Where we made one pound per cow, we now make one pound for every seven cows, and sometimes less; the quantity is so reduced that we often do not think it worth the risk of imparting sourness to the cheese, but turn the whey off to the pig-tank. Some persons tell us that we lose a great deal of valuable food in our whey, as proved by the bacon fatted from it. When bacon is fatted from whey alone this must be the case; but the whey from a cheese well and carefully made would not fatten a pig in six months.

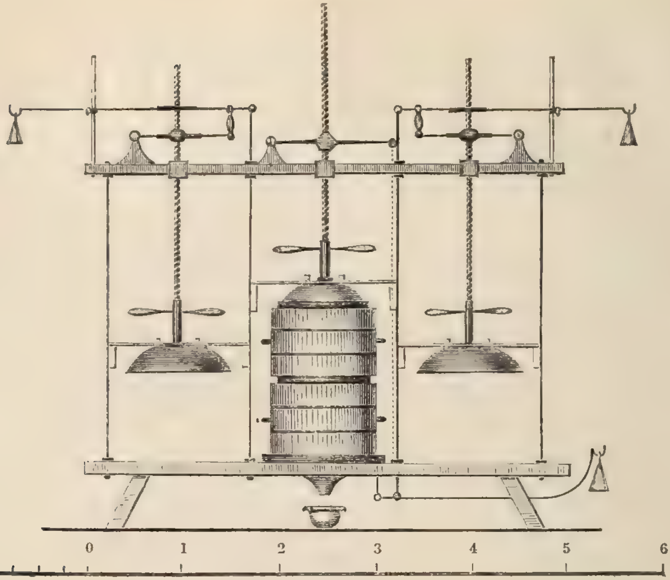
To the cheese consumers of London, who prefer an adulterated food to that which is pure, I have to announce an improvement in the annatto with which they compel the cheesemakers to colour the cheese. The improvement is not in the smell, which remains as unpleasant as ever; neither is it in the taste—that is as filthy as ever; but it consists in this—that we now get annatto in a liquid state, instead of a cake, which saves the trouble of rubbing out.

I have now enumerated the principal improvements in dairy practice that have enabled us to send into the market a superior article, increased in quantity 25 per cent., at a reduction of the original labour of more than half. Although we have attained this result by studying, as far as our observation and experience go, the state of the curd through the various stages and manipulations which it undergoes, and have acquired, so far, some knowledge of what we are doing, we have not yet arrived at perfection. *Cheesemaking, as a science, is not understood.* I could ask a dozen questions, which suggest themselves at

the various stages of the process, and which cannot now be answered.

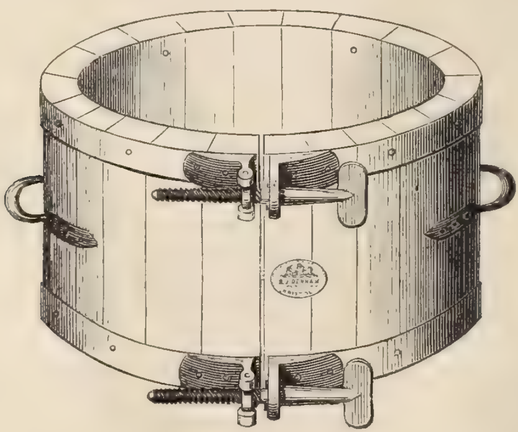
We have now a valuable body of rules laid down for our guidance; though strict observation and practical experience are, of course, requisite for their successful application. But this is not enough. A wide and unexplored field is before us, into which we should enter. Milk, as taken from the cow, is of a peculiarly rich and delicious flavour. The object of the cheese-maker should be to preserve that flavour throughout the process, and leave it to ripen in the cheese; but the accomplishment of this design is not always certain (especially in thunder weather), in the absence of an instrument with which we are not yet provided. Liebig and other chemists tell us that milk, in its pristine state, possesses a quantity of sugar, which, in the process towards decomposition, produces lactic acid. Alkalies are also present which neutralize the acid until an increased amount of the latter is generated, when the milk becomes sour. Believing this to be true, and knowing that heat promotes the formation of the acid, when the temperature of the atmosphere is 65° we act cautiously lest we should make the cheese sour, and, no doubt, our precaution is frequently attended with success. But there are other agents besides heat which promote the souring of the milk, even when the atmosphere is as low as 60°: over these we have no control at the time, besides being generally unaware of their existence until it would be too late to seek a remedy, if any such were known to exist. The instrument, then, which we want is one which will show us the exact amount of acid present, that we may know when to introduce the rennet, and in what quantity. It is true, we have litmus-paper, but this only indicates the presence of acid without measuring the *quantity* present. Whilst searching for such an instrument as this among opticians and chemists for several years past, I have been recommended to try one or two chemical methods, the best of which is by Dr. Cameron, of Dublin. None of these tests, however, are sufficiently simple to be of much use to the practical dairywoman, who wants an instrument effective and simple, by which she can as easily test the amount of acid present, as she can by the thermometer ascertain the degree of heat.

Another desideratum is a chemical knowledge of the constitution of the curd and whey throughout the process. It is not likely that this investigation should be carried out by the unaided efforts of any practical man; but with assistance, such as the Royal Agricultural Society of England could render, this object could be attained, and the result would be that cheese could be made (as it ought to be) upon principles scientific and, consequently, unerring.



3-4ths of an inch to a foot.

The above press is the only one I have in use for 72 cows; the other principal utensils are—cheese-tub, 2 milk-coolers, curd-mill, 6 vats for summer use, 6 smaller ones for the spring and autumn. The press was made by Stokes, of Dean, near Shipton-Mallet, and cost about 9*l.*



The expanding Cheese-vat.

Marksbury, near Bristol.

V.—*On the Composition of two Varieties of Kohl-Rabi and of Cattle-Cabbage.* By Dr. Augustus Voelcker.

There are two crops which deserve to be more extensively cultivated than they are at present: the one is Kohl-rabi, the other Cattle-cabbage. Both crops have this in common, that they are not injured by frost, provided that the young plants are not planted out too early in the spring, in which case they get over-ripe before the winter sets in, and in a rainy and warm autumn or mild winter are certain to be spoiled. If Kohl-rabi or cabbages, therefore, are intended as winter food for cows or sheep, they should not be planted out too soon, nor should the whole crop be put out at one time. When the seed has been sown and the young plants set out at proper intervals of time, a regular succession of cabbages or Kohl-rabi may be kept up as easily in the field as it is in a vegetable garden, and a supply of very nutritious and wholesome food be secured at periods of the year when other food is scarce.

Kohl-rabi especially stands the frost remarkably well. In Germany, where a small variety is grown in gardens for the table, it is not considered good until it has stood at least a week's hard frost. As food for lambs it far surpasses white turnips, and is equal to any kind of green food with which I am acquainted. With proper management it may be grown so as to come in at the lambing season; and even should the bulbs sprout abundantly and become themselves deteriorated or unfit for food, still I believe that sheep-breeders will not regret having reserved a Kohl-rabi field for the lambing season, instead of one of white turnips, because the tops and sprouts of Kohl-rabi, unlike those of the white turnip, are very nutritious. The Kohl-rabi is a plant which belongs, as most readers of this Journal are aware, to the cabbage tribe. Its leaves consequently resemble in taste, composition, and nutritive properties, those of the cabbage much more than those of the turnip, which latter are more watery and far less nutritious.

I much regret that I had no opportunity last season of obtaining the leaves of Kohl-rabi plants for analysis; but as it is my intention to examine this season a large number of bulbs of Kohl-rabi, I shall at the same time direct my attention to the composition of the leaves.

In the mean time the subjoined analysis of two varieties of Kohl-rabi may be of some interest to those who intend to grow this crop. The bulbs were kindly supplied to me by Mr. Innes, steward to Colonel North, who was a successful grower of Kohl-rabi last year, and has formed a decidedly favourable opinion of

its practical feeding value. The varieties analysed by me are known to seedsmen as the Green-top and Purple-top Kohl-rabi.

Composition of Green-top and Purple-top Kohl-Rabi.

a. *General Composition.*

	Green-top.		Purple-top.	
Water	86·020		89·002	
Substances soluble in water	9·260	Dry matter	7·588	Dry matter
Substances insoluble in water	4·720	13·98	3·410	10·998
	100·000		100·000	

b. *Detailed Composition.*

	Green-top.	Purple-top.
Water	86·020	89·002
Oil	·227	·177
*Soluble protein compounds	2·056	2·006
Sugar, gum, and pectin..	6·007	4·486
Salts soluble in water	·970	·919
†Insoluble protein compound	·300	·269
Digestible fibre and insoluble pectinous compounds	2·993	1·896
Woody fibre (cellulose)	1·230	1·106
Insoluble mineral matters	·197	·139
	100·000	100·000
*Containing nitrogen	·329	·321
†Containing nitrogen	·048	·043
Total nitrogen	·377	·364
Percentage of ash	1·167	1·058

It must not be inferred from the preceding analytical results that purple-top Kohl-rabi is necessarily more watery than the green-top variety. My observations only apply to those bulbs which I had an opportunity of examining. A series of determinations of water in a larger number of bulbs of each kind probably would have proved that the apparent superiority of the green-top variety is not real, but due entirely to the accidental occurrence of a smaller proportion of water in the root which was submitted to me for analysis.

It is well known that the proportion of water in roots drawn from the same field and growing in close proximity to each other varies much. All that can be said, therefore, is, that the particular specimen of the green-top variety which I analysed was less watery and no doubt also more nutritious than that of the purple-top.

The following table gives the composition of these two varieties of Kohl-rabi in a perfectly dry state:—

Composition of Kohl-Rabi, dried at 212° F.

	Green-top.	Purple-top.
Oil	1·623	1·609
*Soluble protein compounds	14·706	18·239
Sugar, gum, and pectin	42·968	40·789
Salts soluble in water	6·938	8·356
†Insoluble protein compounds	2·145	2·445
Digestible fibre and insoluble pectinous compounds	21·409	17·239
Woody fibre (cellulose)	8·798	10·056
Insoluble mineral matters	1·409	1·263
	99·996	99·996
*Containing nitrogen	2·353	2·918
†Containing nitrogen	·343	·390
Total nitrogen	2·696	3·309
Percentage of ash	8·347	9·619

A comparison of the preceding results with the analyses of swedes, mangolds, and turnips, shows that theoretically Kohl-rabi is much more nutritious than white turnips, and fully equal, if not superior, to swedes and mangolds. These remarks, however, I would remind the reader, apply only to the specimens which I had an opportunity of examining. Future examinations, and, above all, practical feeding experiments, are required to establish fully the comparative feeding value of Kohl-rabi.

I may remark with respect to the Kohl-rabi, that it is an excellent food for milch-cows, inasmuch as it produces much and good milk. The butter made of such milk has a pleasant taste, altogether unlike the disagreeable flavour that characterizes butter made from the milk of cows fed upon turnips.

Composition of Cattle-Cabbage.

As yet not many complete analyses of field-cabbage have been published. I do not recollect having seen any one that could be relied on, with the exception of that by Dr. Anderson published a few years ago in the Highland Society's Transactions. It appeared to me, therefore, desirable to make a full analysis of this useful crop. The specimen examined in my laboratory was grown on the farm attached to the Royal Agricultural College, Cirencester. A preliminary trial showed that the outside leaves contained much less water than the inner, for which reason both were examined separately. The whole cabbage was divided into two parts: the one consisting of the outer green leaves, the other of the heart with the paler inner leaves attached to it.

The following tabular results represent the general composition of both parts of the cabbage :—

Composition of Cabbage-leaves (outside green leaves).

Water	83·72
Dry matter	16·28
	100·00

The Dry matter consisted of :—

		Dry Matter per Cent.
*Protein compounds	1·65	10·19
Non-nitrogenous matter	13·38	82·10
Mineral matter	1·25	7·71
	16·28	100·00
*Containing nitrogen	·26	1·63

General Composition of Heart and Inner Leaves.

	In Natural State.	Dry.
Water	89·42	..
Soluble organic matter	6·20	18·60
Soluble mineral matter	·73	6·89
Insoluble organic matter	3·53	33·36
Insoluble mineral matter	·12	1·15
	100·00	100·00

It will be observed that the outer green leaves contain nearly 6 per cent. less water than the heart and inner leaves.

In the next table the detailed composition of the heart and inner leaves together is stated both in the natural state and when dried at 212° F. :—

Detailed Composition of Heart and Inner Leaves of Cabbage.

	In Natural State.	Dry.
Water	89·42	..
Oil	·08	·75
*Soluble protein compounds	1·19	11·24
Sugar, digestible fibre, &c.	7·01	66·25
Soluble mineral matter	·73	6·89
†Insoluble protein compounds	·31	2·93
Woody fibre	1·14	10·77
Insoluble mineral matter	·12	1·17
	100·00	100·00
*Containing nitrogen	·19	1·79
†Containing nitrogen	·05	·47

Cabbages contain about the same proportions of water, sugar, and protein compound as are found in good swedes. On the whole, I am inclined to think, weight for weight, cabbages and swedes possess nearly the same nutritive value.

In ordinary seasons the average produce of swedes on our poorer fields is about 15 tons per acre. On weighing the produce of an acre of cabbage, grown under similar circumstances, I found that it amounted to 17½ tons per acre in round numbers. On good, well-manured fields, however, we have had a much larger produce.

Royal Agricultural College, Cirencester, June, 1860.

VI.—*On the Composition and Nutritive Properties of Mangold-pulp (the Refuse of Beet-root Distilleries).* By Dr. Augustus Voelcker.

In beet-root distilleries a refuse is obtained, known by the name of Mangold-pulp. According to the method of Leplay, the fermentation is carried on in the sliced roots, and the spirit is separated by superheated steam passed through the mass in closed vessels. The residual matter left in the stills after the process of distillation is completed, is thrown aside in heaps, and the excess of water allowed to drain off, after which it constitutes the mangold-pulp.

The material from which the subjoined analyses were made was obtained from a mangold-root distillery which was established a few years ago at Minety, in Wiltshire, a village about eight miles from Cirencester. This distillery was erected by a company, formed under the Limited Liability Act, which is no longer in being. After a brief period of existence the company were obliged to wind up their affairs, the undertaking having proved a complete failure.

The method adopted by the company was that of Leplay, which method, I believe, has been entirely superseded in France by that of Champonnois. I examined at different times two samples of mangold-pulp, differing, as will be seen by the analytical results, chiefly in the amount of water which they contained respectively. The first sample, on analysis, gave the following results:—

General Composition of Mangold-pulp.

	In Natural State.	Dry.
Water	90·78	...
Soluble organic matter	2·86	30·65
Soluble mineral matter	·56	6·17
Insoluble organic matter	5·26	57·47
Insoluble mineral matter	·54	5·71
	100·00	100·00

Detailed Composition.

	In Natural State.	Dry.
Water	90·78	..
*Soluble protein compounds	·61	6·67
Gum, mucilage, a little sugar, and free acid	2·21	23·98
Soluble mineral matter	·56	6·17
†Insoluble protein compounds	·76	8·25
Crude woody fibre	4·53	49·22
Insoluble mineral matter	·55	5·71
	100·00	100·00
*Containing nitrogen	·09	1·07
†Containing nitrogen	·12	1·32

In the distillation of mangold-spirit a considerable quantity of sulphuric acid is added to the sliced mangolds. The residual pulp consequently has a decidedly acid taste, and, when obtained by Leplay's process, does not readily enter into fermentation, but remains unaltered, and fit for food for a considerable length of time. The second sample had the following composition:—

General Composition of Second Sample of Mangold-pulp.

	In Natural State.	Dry.
Water	91·84	..
Soluble organic matter	2·61	32·07
Soluble mineral matter	·38	4·75
Insoluble organic matter	4·70	57·58
Insoluble mineral matter	·47	5·60
	100·00	100·00

Detailed Composition.

	In Natural State.	Dry.
Water	91·84	..
*Soluble protein compounds	·64	7·87
Gum, mucilage, a little sugar, and free acid	1·98	24·31
Soluble mineral matter	·38	4·75
†Insoluble protein compounds	·69	8·50
Woody fibre	3·99	48·97
Insoluble mineral matter	·48	5·60
	100·00	100·00
*Containing nitrogen	·09	1·26
†Containing nitrogen	·11	1·36

The second sample thus contains about 1 per cent. more of water, but does not otherwise materially differ in composition from the first. Both samples had a greyish-white colour, and presented rather an uninviting appearance. The surface portions of a heap of the pulp turned almost black on lengthened exposure to the air.

Notwithstanding the somewhat disagreeable appearance and acid taste of the pulp, pigs from the first ate it up greedily when

it was given to them unmixed with any other food. Cows and sheep at first would not touch it; on mixing the pulp, however, with clover-chaff they did not object to it, and by degrees seemed to acquire a liking for the mess.

I shall presently give an account of some feeding experiments instituted with a view to ascertaining practically the comparative fattening value of the pulp and of fresh mangold-wurzel. But as many persons entertain very erroneous opinions respecting the relative value of the different constituents of food, and their adaptation to particular purposes, and as it may be at all events interesting to most to trace the changes which mangolds undergo in the process of distillation, I shall briefly endeavour to describe these changes. We shall best comprehend this matter by comparing the composition of the pulp with that of the mangold-root from which it is made. Two specimens of yellow-globe mangolds, analysed by me some time ago, were found to contain in 100 parts:—

Composition of Yellow Globe Mangolds.

	1.	2.
Water	87·440	88·450
Sugar, gum, and soluble pectin compounds ..	7·408	7·538
Soluble mineral matters	1·356	·952
*Soluble albuminous compounds	·956	·887
†Insoluble albuminous compounds	·144	·104
Cellular fibre and insoluble pectinous compounds (crude fibre)	2·583	1·995
Insoluble mineral matters	·113	·074
	100·000	100·000
*Containing nitrogen	·153	·142
†Containing nitrogen	·023	·017
Total nitrogen	·176	·159

A comparison of these analyses with the preceding analytical results, representing the composition of pulp, will show—

1. That the proportion of water in the pulp is increased nearly $3\frac{1}{2}$ per cent.;

2. That the sugar has almost entirely disappeared in the pulp;

3. That the proportion of crude woody fibre is very much larger in the pulp than in the root itself;

4. That notwithstanding the larger amount of water in the pulp, it contains more albuminous or flesh-producing matter than the mangold-roots;

5. That the roots contain more soluble albuminous matters than the pulp; and

6. That the proportion of soluble mineral matters is more considerable in the roots than in the pulp.

In short, all the soluble constituents of mangolds, more especially the sugar, are much more sparingly present in the pulp than in the root; and the insoluble matters, especially crude woody fibre, are more abundant in the pulp than in the root itself.

Since there is nearly $3\frac{1}{2}$ per cent. more water in the pulp than in the root, the comparison of the pulp in its natural state with the fresh root does not bring out as strikingly the changes which mangolds experience in the distiller's hands as would be the case if both contained the same amount of water. I have, therefore, calculated the composition of the two mangold-roots in a perfectly dry state, and placed in the subjoined Table the results side by side with those which represent the composition of the two specimens of dried pulp.

Composition of Two Specimens of Mangold-wurzel and Pulp, dried at 212° F.

	Mangolds, Orange Globe.		Pulp.	
	1.	2.	1. [a]	2. [a]
Sugar, gum, and soluble pectin compounds	58·98	65·26	23·98	24·31
Soluble mineral matter	10·79	8·24	6·17	4·75
*Soluble albuminous compounds	7·62	7·68	6·67	7·87
†Insoluble albuminous compounds	1·14	·89	8·25	8·50
Cellular fibre and insoluble pectinous compounds (crude fibre)	20·57	17·28	49·22	48·97
Insoluble mineral matters ..	·90	·65	5·71	5·60
	100·00	100·00	100·00	100·00
*Containing nitrogen	1·22	1·23	1·07	1·26
†Containing nitrogen	·18	·14	1·32	1·36
Total nitrogen	1·40	1·37	2·39	2·62
Equal to protein compounds	8·76	8·57	14·92	16·37

[a] There is scarcely any sugar included in these numbers.

The preceding figures suggest the following observations:—

1. In the same state of dryness mangold-wurzel contains $2\frac{1}{2}$ times as much sugar, gum, and soluble pectinous compounds as the pulp.

The average proportion of these soluble organic matters in the two roots, dried at 212° Fahr., and analysed by me, is 62·12 per cent. In the dried pulp the average of the two samples is only 24·4. There is thus a difference of 37·9, or 38 per cent. in round numbers, in favour of the mangolds.

2. On the other hand, in the same state of dryness, the pulp contains nearly double the quantity of albuminous compounds that is found in the root.

The average proportion of albuminous compounds in the dry mangolds is 8·66; in the pulp it is 15·64—thus leaving a difference of 7 per cent., in round numbers, in favour of the pulp.

3. Mangolds contain much less crude fibre than the pulp, with an equal proportion of water.

The average amount of crude fibre in the two mangolds dried at 212° Fahr. is 18·92; the mean of fibre determinations in the two specimens of pulp, 49·09. We have thus a difference of 30 per cent. of crude fibre in favour of the pulp. Minor differences which will be observed in the composition of the pulp and the root itself may be left unnoticed, for they are less striking in themselves and immaterial in a consideration of the comparative feeding value of the two substances.

A careful consideration of the differences just pointed out in the composition of pulp and roots will enable us to decide with no great difficulty:—

1. That, weight for weight, pulp similar to that analysed by me cannot possibly have the same feeding value as good mangold-wurzels.

2. That such pulp, however, is a refuse material which possesses high feeding properties.

To prove that the pulp examined by me is not equal in nutritive value to the good mangolds, I need only state that the latter were found to contain nearly 3½ per cent. more dry matter than the pulp. In materials containing so much water as exists in mangolds or pulp, this difference alone is sufficient to settle the question, whether a ton of pulp is as nutritious as a ton of mangolds. The average percentage of dry matter in the two mangolds examined by me is 12·05. A ton of mangolds therefore contains 270 lbs. of dry substance in round numbers. On the other hand, the mean of the water determinations in the two specimens of pulp is 91·31, which leaves 8·69 of solid matter in 100 parts of pulp. A ton of pulp accordingly contains 194½ lbs. of solid matter. In 1 ton of mangolds there were thus 76½ lbs. more of solid feeding-matter, or more than one-third more feeding-matter, than in 1 ton of pulp. Unless therefore the dry matters which compose the pulp are greatly superior in feeding properties, mangolds must have a decided advantage over the pulp which I analysed.

It is not difficult to prove that this is not the case. I have just pointed out that mangolds contain 2½ times as much sugar, gum, and soluble pectinous compounds. In the perfectly dry root we have 38 per cent. more of these substances than in the pulp. The latter indeed hardly contains any sugar; and I question much whether the soluble non-nitrogenised substances in the pulp have the same practical feeding value as the sugar and other soluble non-nitrogenised substances in the root itself. However, leaving the question as to the comparative value of the soluble non-nitrogenised matters of the pulp and of

mangolds undecided, we have at all events 38 per cent. of fattening and very readily-digestible materials in favour of the roots. But against this must be placed the 7 per cent. albuminous compounds, and the 30 per cent. of crude fibre, which the pulp contains more than the roots. The question, therefore, would appear to resolve itself simply to this: Is 7 per cent. of albuminous compounds, and 30 per cent. of crude pulp-fibre, as valuable as 38 per cent. of sugar? But it is not really quite so simple; for, in comparing the crude fibre of the root with that of the pulp, we have assumed that both have the same feeding value; which is not the case in reality. Of the crude fibre contained in the mangold, a much smaller portion is woody indigestible fibre than in that of the pulp; for it includes insoluble pectinous compounds, which, under the action of sulphuric acid, employed in beet-root distilleries, are readily transformed into sugar, and thus rendered soluble. The fibre of the pulp, after deducting the insoluble albuminous compounds which remain attached to it, consists almost entirely of woody fibre. Weight for weight, therefore, the crude fibre of mangolds is more valuable than the crude fibre of the pulp. But even supposing the crude fibre of the pulp to be equally nutritious with the crude fibre of the root, I am not the less convinced that this 38 per cent. of soluble non-nitrogenous matters (consisting chiefly of sugar) contained in the latter will go farther in producing butcher's-meat than the 7 per cent. of albuminous compounds, together with 30 per cent. of fibre found in the former; and for this reason,—because we have already seen that the mangold in its natural state contains more than a sufficient quantity of flesh-forming or albuminous substances to meet the requirements of the animal system.

It is for these reasons that I consider mangolds more nutritious than pulp. We shall presently see how far these speculations are borne out by actual experience. I may however be permitted to combat in this place the opinion, which appears to be pretty generally entertained by French writers, that little or no feeding value is to be ascribed to sugar, and that, chiefly on this account, the pulp may be considered to be as nutritious as an equal weight of roots. In my opinion the sugar is by far the most important constituent in our root-crops; and those farmers who judge of the quality of their swedes or mangolds by the more or less sweet taste which they possess, may be satisfied that instinctively they rely on a trustworthy test.

I shall now describe the experiments which I instituted with a view of testing *practically* the relative feeding value of mangold and of pulp, the latter being the refuse of a distillery in which Leplay's system was adopted.

Eight Cotswold sheep were divided into two lots. Before the

experiment began, one lot was kept for 10 days upon mangold-wurzel, clover-hay, and a little linseed-cake; the second lot was fed for the same period upon mangold-pulp, clover-hay, and a little linseed-cake. This preliminary trial was made to accustom the sheep gradually to their diet. After ten days the sheep were accurately weighed. The sheep in Lot I., fed with pulp, weighed—

Sheep No. 1	124 lbs.
„ 2	151 „
„ 3	146 „
„ 4	137 „
Total weight	558 „

The sheep in Lot II., fed upon mangolds, weighed—

Sheep No. 1	153 lbs.
„ 2	134 „
„ 3	170 „
„ 4	136 „
Total weight	593 „

The experiment began on the 22nd of March, and terminated on the 10th of May, when no more pulp could be obtained, the distillery having stopped its operations.

The first lot received per day 1 lb. of linseed-cake, 4 lbs. of clover-hay chaff, or ¼ lb. of cake, and 1 lb. of hay per sheep, and as much pulp as the sheep felt inclined to eat. The second lot received per day the same allowance of linseed-cake and clover-hay chaff as the first, with as much of sliced mangolds as the sheep could consume. Both lots were fed three times a day. At 7 o'clock in the morning Lot I. got pulp mixed with 2 lbs. of clover-hay chaff; Lot II. got sliced mangolds and 2 lbs. of clover-hay chaff. At 12 o'clock each lot received 1 lb. of crushed linseed-cake—Lot. I. mixed with pulp, Lot II. with sliced roots. The sheep were again fed at 5 o'clock in the evening; Lot I. with 2 lbs. of clover-hay mixed up with pulp; Lot II. with 2 lbs. of clover-hay mixed with sliced mangolds. In mixing the clover-chaff with pulp, sliced roots, and cake, a limited quantity of pulp and roots were used, in order to insure the entire consumption of the hay and cake; care, however, was taken to keep the feeding-troughs constantly supplied with pulp and sliced roots respectively, so that the sheep could help themselves at all times to as much pulp and roots as they liked. The pulp and mangold which were given to the sheep were of course weighed.

The following quantities of food were consumed during the whole experimental period of 7 weeks:—

Lot I., 4 sheep fed upon pulp, consumed 196 lbs. of clover-hay

chaff, 49 lbs. of linseed-cake, 34 cwts. 2 qrs. 21 lbs. of mangold-pulp.

Lot II., 4 sheep fed upon mangolds, consumed 196 lbs. of clover-hay chaff, 49 lbs. of linseed-cake, 33 cwts. 1 qr. 19 lbs. of mangolds.

It will be observed that the sheep in the first lot consumed 1 cwt. 30 lbs. more pulp than the quantity of roots eaten by the sheep in the second lot. Each sheep was weighed on the 12th of April, 26th of April, and May 10th. The weight of each sheep at these periods, and their final increase, is given in the subjoined Table:—

TABLE *showing the Weight of each Sheep in lbs. at beginning of Experiment and at different times of Experimental period, and Final Increase.*

LOT. I.—*Four Sheep fed upon Mangold-pulp.*

	Put up on March 22.	April 12.	April 26.	May 10.	Increase.
	lbs.	lbs.	lbs.	lbs.	lbs.
Sheep No. 1 weighed	124	130½	133	138½	14½
,, 2 ,,	151	142	139½	148	− 3
,, 3 ,,	146	152	154½	162½	16½
,, 4 ,,	137	147	143	150	13
Total	558	571½	570	599	41

LOT II.—*Four Sheep fed upon Mangolds.*

	Put up on March 22.	April 12.	April 26.	May 10.	Increase.
	lbs.	lbs.	lbs.	lbs.	lbs.
Sheep No. 1 weighed	153	154½	164	170½	17½
,, 2 ,,	134	136½	145½	151½	17½
,, 3 ,,	170	171	181½	187½	17½
,, 4 ,,	136	140	148½	155	19
Total	593	602	639½	664½	71½

It appears thus that the 4 sheep fed upon mangold gained 30½ lbs. more in weight than the 4 sheep fed upon pulp, although the latter consumed 1 cwt. 30 lbs. more of pulp. One of the sheep in the first lot, it will be noticed, lost 3 lbs. in weight. This is due to the sheep having been affected with scouring after it had been fed for some time upon pulp. The pulp, which is very acid, is apt to produce this disorder. It ought therefore always to be given with a good deal of dry food.

These experiments, though deficient in some respects, I think still confirm sufficiently the theoretical opinion to which I have been led by the analysis of the pulp and of mangold-wurzel.

The linseed-cake used in the experiment was good American barrel-cake, and was found to contain, in 100 parts,—

Moisture	11·56
Oil	11·56
Gum, sugar, mucilage, and digestible fibre	28·47
*Albuminous compounds (flesh-forming matters) ..	26·37
Woody fibre (cellulose)	13·92
Mineral matters (ash)	8·12
	100·00
* Containing nitrogen	4·22

The clover-hay chaff contained 20·12 per cent. of water, 6·89 per cent. of ash, and 1·52 per cent. of nitrogen. Mangolds and pulp had the composition which has been given already in the preceding pages.

Although my analyses and feeding experiments have proved the pulp to be inferior in feeding properties to mangold-wurzel, I am of opinion that the pulp is a very useful feeding material, which, at 10*s.* a ton, the price at which it was sold, is certainly not dear.

I would observe, in conclusion, that more favourable results than mine have been obtained with pulp in numerous experiments carried out in France. It should be borne in mind, however, that in France, Champonnois' method of distillation has almost entirely superseded Leplay's, and that French writers expressly state that the pulp produced by Leplay's process is much inferior to the pulp of distilleries where Champonnois' system is adopted. The differences in the composition of the pulp used in my experiments and that generally produced in France may thus explain discrepancies in the results, and probably justify the opinion of several French authorities, who consider the pulp, weight for weight, to be, if not superior, at least equal in nutritive properties to mangolds.

Royal Agricultural College, Cirencester, June, 1860.

VII.—*On the Chemical Properties of Soils.* By Dr. Augustus Voelcker.

There are many persons who, on reading the papers which from time to time appear in our chemical and agricultural journals on the powers of soils to absorb manuring matters, receive the impression that sandy soils have not the power of retaining ammonia, whilst clay soils are imbued with this property in so eminent a degree, that no amount of rain is capable of removing any of the ammonia absorbed by them.

These impressions, though natural, are not founded on fact. It will be one of the objects of this communication to show by many experiments the fallacy upon which these erroneous impressions are based.

If soluble fertilizing matters were rendered completely insoluble when brought into contact with the soil, it would indeed be difficult to understand the use of soluble manuring matters, or to doubt the policy of resorting to mechanical means of cultivation, such as subsoiling, stirring, &c., which have the effect of rendering soluble mineral matters contained in the soil in an insoluble state. But does not daily experience teach us that such fertilizers are much more effective than the same materials in an insoluble or partially soluble condition?

It has indeed been stated by a high authority, that since soluble fertilizing matters are rendered insoluble in contact with soil, plants must have the power of taking up their food from the soil in some other form than that of simple solution. It is here taken for granted that soluble matters become quite insoluble in contact with soil. Many people, on being told that plants do not take up their food from the soil in the state of simple solution, assume that they take it up in a solid form.

It is not my intention to expound in this place Baron Liebig's views on the assimilation of the food derived by plants from the soil. The changes which fertilizing matters undergo in contact with soil are, as we know, so numerous and so little understood, and the precise combinations in which mineral food is taken up by plants so little known, that it would be extremely hazardous to propound in detail a new theory respecting the assimilation of mineral food by plants. Baron Liebig, therefore, wisely refrained from expressing his views on this subject in that clear and precise manner which generally distinguishes his writings, and very properly contented himself with indicating that our present views respecting the absorption of mineral matters by plants are not quite correct.

Professor Way's and my own researches certainly have shown that manuring matters in contact with soil undergo remarkable changes, and fully justify the statement that plants do not take up mineral food in the simple state of solution in which we add it to the soil in the shape of manure, but in totally different states of combination.

Again, if sandy soils had not the power of retaining soluble fertilizing matters, it would be difficult to comprehend how, notwithstanding the occurrence of heavy thunderstorms or long-continuing rains, the effects of superphosphate or guano, or even sulphate of ammonia, are clearly seen in the increased produce raised on such soils by the aid of these manures.

The quantity of water running through the soil at such times, is amply sufficient completely to dissolve the soluble manuring matters. If it were, therefore, quite correct that sandy soils had not in any degree the power of absorbing soluble manuring matters, they would be removed by the rain into the subsoil, neighbouring ditch, or drain, and could scarcely produce any effect upon vegetation.

Experience teaches us that the same kinds of manure produce very different practical results upon different soils. It must be admitted that the composition of different soils varies considerably, and that this circumstance, no doubt, accounts to some extent for the variations in the practical results.

There are, however, many apparently similar soils, that is to say, soils in which the analysis shows like quantities of the same constituents, such as potash, soda, lime, magnesia, phosphoric, sulphuric and silicic acid, and all the elements present in the ashes of plants, in which, notwithstanding, the same kind of manure produces a different practical result. This appears to me to indicate that the analysis of soils, as usually performed by chemists, does not afford in all cases a sufficient guide to estimate their agricultural capabilities, nor to point out the kind of manure which is particularly well adapted for the special crop which we wish to raise. Even a detailed analysis of a soil gives only the proportions of the different soil-constituents, but generally without reference to the states of combination in which they exist in the soil; and is altogether silent on the property possessed by all soils, in a higher or lower degree, of effecting striking and important changes in the manuring matters which are placed upon the land.

That this property belongs to every soil has been recently shown by me and others who have investigated this subject. It has likewise been shown that some soils possess the power of modifying the composition of manures much more thoroughly than others. It is, therefore, reasonable to connect the agricultural capabilities of soils in a great measure with their power of retaining certain fertilizing matters with avidity, and of modifying others in a most interesting and unexpected manner.

It is hardly necessary to dwell upon the importance of an accurate knowledge of the inherent capacity of soils to work up, so to speak, the crude fertilizing matters into new combinations; to allow the free percolation of other—it may be less needful—substances, and to provide for a constant supply of food which is neither so soluble as to injure the produce, nor so insoluble as to remain inactive.

The investigation of the exact circumstances under which these properties manifest themselves demands our serious and imme-

diate attention. We stand on the threshold of a wide and fertile field of research, and cannot hope to make any material progress in the practical cultivation of soils and the economy of manures until this subject has been to some extent investigated in a truly scientific manner, independently of all direct application. Useful applications will as assuredly follow from the sure establishment and clear recognition of scientific principles, as good works from the principle of Christian love deeply engraven in the heart of man.

It must, therefore, ever be the primary object of every student of nature to increase our knowledge of scientific facts, and thus to furnish the materials from which principles can be deduced. and upon which rational theories can be built. Perhaps no theory in physical science is absolutely true; nevertheless if it fulfil the chief purpose of every good theory, that is, the arrangement of existing scientific facts in a comprehensive form, and their preservation as a common inheritance to mankind, and so leads to an extension of our knowledge of material things, no theory, however erroneous subsequent researches may prove it to be, can be called vain.

No one who has carefully examined the curious and mysterious properties of soils in relation to manuring matters will hastily propound a new theory on the nutrition of plants whilst our range of observation is as limited, and our chemical facts as imperfectly ascertained, as is now the case. Such presumption would, in the end, only bring discredit upon the author.

The description of chemical facts and the proofs upon which they rest is necessarily a hard and dry subject to the uninitiated. It is nevertheless of great consequence to preserve in a Journal like that of our great national Agricultural Society faithful accounts of original researches in agricultural chemistry, however uninteresting and abstruse they may appear to the practical man.

The present communication deals chiefly with chemical facts, having a more remote but nevertheless important bearing upon practical agriculture. I wish it to be regarded as the first instalment of a series of similar researches, which will probably occupy me for the rest of my life, however long I may be permitted to retain my energies and zeal for the promotion of agricultural progress.

First Series of Experiments on the Absorption of Caustic Ammonia.

The object I had in view in instituting this first series of experiments was simply to ascertain the quantity of ammonia which a given quantity of different soils of known composition

removed from a weak solution of caustic ammonia prepared with distilled water, and to compare the results with those obtained by other observers from similar experiments on other soils.

The ammonia solution used in the subsequent experiments was of the same strength as that before used, and contained 23·24 grains of ammonia ($N U_3$) in the gallon, or ·332 grains of ammonia in 1000 grains of liquid.

The soils employed in these and all following experiments were :—

1. A calcareous clay.
2. A fertile loam, containing a little lime, mixed in equal proportion with the clay subsoil on which it rests.
3. The surface and subsoil of a heavy clay field, containing scarcely any sand.
4. A sterile sandy soil, containing much organic matter, and scarcely any lime.
5. Pasture land, being a vegetable mould containing abundance of organic matter and a fair proportion of sand and clay.

These soils were preferred to others for experimental purposes on account of their widely differing physical and chemical properties. They afford good examples of some of the more frequent and important varieties of British soils.

First Experiment, on Calcareous Clay.

The soil used in the first experiment contained, in 100 parts :—

Moisture	1·51
Organic matter and water of combination	11·08
Oxides of iron and alumina	14·25
Carbonate of lime	10·82
Sulphate of lime	·71
Magnesia	·51
Potash (in acid solution)	·32
Soda (in acid solution)	·05
Phosphoric acid	·10
Insoluble silicates and sand (chiefly clay)	60·65
	100·00

Submitted to a mechanical analysis it yielded :—

Moisture	1·51
Organic matter and water of combination	11·08
Carbonate of lime	10·82
Clay	52·06
Sand	24·53
	100·00

3000 grains of this soil were shaken up in a glass-stoppered

bottle with 14,000 grains of ammonia solution, containing 23·24 grains of caustic ammonia in the imperial gallon. In the course of the day the bottle was repeatedly shaken, and the liquid then left to subside. After standing for three days the soil had all settled to the bottom, and the greater part of the liquid could be drawn off in a perfectly clear condition. This liquid was slightly tinged with yellow.

2000 grains of this clear liquid were then carefully neutralised with a standard solution of sulphuric acid of known strength. It being known how much of the test acid was required to neutralise the ammonia solution before contact with soil, the amount of ammonia retained in the soil could be readily calculated:—

	Ammonia. Grains.
Before contact with the soil the solution contained in 1000 grains	·332
After contact	·135
Difference	·197

·197 grains of ammonia were thus removed from each 1000 grains of solution, consequently 2·758 grains of ammonia were removed from 14,000 grains of solution and retained in 3000 grains of soil.

In this experiment accordingly 1000 grains of soil absorbed ·9193 grains of ammonia. A repetition of the same experiment gave precisely the same results. The clear liquid poured off the soil being slightly yellow, it occurred to me that the organic matter (humus acids) in the soil possibly might have neutralised a small portion of the free ammonia of the ammoniacal liquid employed in the experiment. As the test-acid cannot indicate any ammonia when previously neutralised by the organic acids of the soil, the proportion of ammonia retained by the latter may be stated rather too high. In order to verify this supposition, I distilled some of the yellow-coloured liquid with caustic potash, in an apparatus which was so constructed that all chance of traces of potash being carried over with the distillate was entirely avoided. The distillate was collected in a measured quantity of acid of known strength, and the amount of ammonia distilled over, carefully determined.

Proceeding in this manner, 1000 grains of liquid, after contact with soil, contained ·143 of ammonia. Before contact with soil it contained ·332 grains. Consequently ·189 were removed from every 1000 grains of liquid, or 2·646 were removed from the whole quantity of liquid employed in the experiment, and retained by 3000 grains of soil, or 1000 grains of soil absorbed ·882 grains of ammonia. Not taking into account the amount of free ammonia neutralised by the organic acids of the soil,

1000 grains of the latter, as we have seen, absorbed ·9193 grains of ammonia. The difference between ·9193 grains and ·882 grains is ·0373 grains, and represents the quantity of ammonia neutralised by the organic matters contained in 1000 grains of the soil. This difference is very small, but it nevertheless confirms my supposition, and at the same time affords a good proof of the delicacy of the method employed in these experiments.

Second Experiment, on Fertile Loamy Soil.

Equal parts of surface and subsoil were mixed together. The surface soil is a friable sandy loam; the subsoil is stiffer, containing less sand and more clay.

The mechanical analysis of this soil and its subsoil gave:—

	Surface-soil.	Subsoil.
Sand	76·16	55·15
Clay	18·09	41·79
Lime, magnesia, &c.	1·37	·47
Organic matter	4·38	2·59
	100·00	100·00

Submitted to detailed chemical analysis, the soil and subsoil were found to contain in 100 parts:—

	Surface-soil.	Subsoil.
Organic matter and water of combination	4·38	2·59
Alumina	2·15	5·39
Oxide of iron	3·15	7·16
Lime	·77	·26
Magnesia	·13	1·22
Potash	·49	·88
Soda	·13	·28
Phosphoric acid	·12	·19
Chlorine	trace.	trace.
Sulphuric acid	·06	·02
Carbonic acid	·31	1·79
Insoluble silicate and sand	88·31	80·24
Consisting of:—		
Silicic acid	85·11	62·61
Alumina	2·36	14·55
Lime	.. ..	·85
Magnesia	·50	·23
Potash	·25	1·77
Soda	·09	·21
	100·00	100·00
* Containing nitrogen	·182	·09
Equal to ammonia	·220	·11

3500 grains of this soil and subsoil were mixed with 14,000 grains of the above ammonia solution, and, after repeated shakings in a well-stoppered bottle, allowed to settle for three days, by which time the liquid became perfectly clear. The greater

portion of the clear solution was then drawn off, and the ammonia contained in it determined in precisely the same manner as in the preceding experiment.

	Ammonia. Grains.
Before contact with soil the solution contained in 1000 grains	·332
After contact	·115
Difference	·217

Thus we see that 217 grains were removed from each 1000 grains of liquid, or 3·038 grains from the whole liquid, and retained by 3500 grains of soil. 1000 grains of soil therefore absorbed ·868 of ammonia. By distillation the amount of ammonia in the liquid after contact with soil was found to be ·131 grains, in 1000 grains of liquid, or 2·814 grains from the whole liquid. Accordingly 1000 grains of soil absorbed ·804 grains of ammonia.

Third Experiment, on Stiff Clay Land.

The mechanical and chemical analysis of the soil and its subsoil furnished the following results:—

Mechanical Analysis.

	Subsoil.	Surface soil.
Moisture	9·46	3·91
Organic matter and water of combination ..	4·87	4·80
Sand	9·26	10·97
Lime	1·12	2·19
Clay	75·29	78·13
	100·00	100·00

Chemical Analysis.

	Subsoil.	Surface soil.
Moisture	9·46	3·91
Organic matter and water of combination ..	4.87	4·80
Oxides of iron and alumina	17·38	7·85
Phosphoric acid	·06	·04
Carbonate of lime	1·02	2·08
Sulphate of lime	·13	·15
Magnesia	·92	·32
Alkalies and loss	·45	
Insoluble siliceous matter (chiefly clay) ..	65·71	80·85
	100·00	100·00

Equal parts of soil and subsoil were mixed together, and 3500 grains of the mixture shaken up with 14,000 grains of ammonia solution, and treated as before mentioned:—

	Ammonia. Grains.
Before contact with soil the solution contained in 1000 grains	·332
After contact	·143
	·189

Consequently ·189 grains of ammonia were removed from every 1000 grains of solution, or 2·646 grains from the whole solution; 1000 grains of soil therefore absorbed ·7543 grains of ammonia.

Fourth Experiment, on Sterile Sandy Land.

100 parts of the soil, dried at 212° Fahr., contains:—

Oxide of iron and a little water of combination	5·36
Oxides of iron and alumina	5·70
Carbonate of lime	·25
Alkalies and magnesia	·49
Phosphoric acid	trace.
Sulphuric acid	·08
Soluble silica	1·01
Insoluble siliceous matter (sand)	87·11
	100·00

It will be seen that this soil hardly contains any lime and abounds in sand. It contains a good deal of organic matter, but very little clay, which will be seen by the subjoined mechanical analysis:—

Organic matter	5·36
Clay	4·57
Lime	·25
Sand	89·82
	100·00

3500 grains of this soil were mixed with 14,000 grains of ammonia solution and left to settle for three days, when the following results were obtained:—

Before contact with soil 1000 grains of ammonia solution contained	·332
After contact with soil 1000 grains contained	·063
	·269

Consequently ·269 grains were removed from every 1000 grains of solution, or 3·766 grains from whole solution.

1000 grains of soil therefore absorbed 1·076 grains of ammonia.

In a second experiment, in which the ammonia was determined by a standard solution of test-acid, in the same manner as in the first experiment, 1000 grains of soil were found to have absorbed 1·136 grains of ammonia.

In both experiments the solution, after remaining in contact with the sandy soil, had a deep yellow colour. The caustic ammonia evidently dissolved a good deal of the organic matter of the soil. The ulmic and humic acids in the soil, in uniting with ammonia, form salts, which are soluble in water, and of a brown colour. A brown coloured solution thus indicates that some

of the ammonia has become neutralised by the organic matters in the soil.

The deeper coloured the ammonia solution after contact with soil, the greater will be the error which will be made if the amount of ammonia is determined in the brown-coloured liquid in a direct manner by the alkalimetrical process. Whenever the solution is distinctly coloured yellow or brown, it should be first distilled with caustic potash, in a properly-constructed apparatus, and the free ammonia be determined in the distillate.

Thus the same ammonia solution which yielded to 1000 grains of this sandy soil, according to the direct process of neutralisation, 1·076 grains of ammonia in one experiment, and 1·136 grains of ammonia in a second experiment, after distillation with caustic potash was found to contain in 1000 grains of liquid ·119 grains of ammonia; consequently, subtracting as before ·119 from ·332 grains, ·213 grains are removed from every 1000 grains of liquid, or 2·982 grains from the whole solution.

	Ammonia. Grains.
In a second distillation :—	
1000 grains of liquid were found to contain	·111
Before contact with soil the solution contained	·332
	·221

Therefore ·221 grains of ammonia were removed from every 1000 grains of liquid, or 3·094 grains from the whole quantity.

	Ammonia. Grains.
According to the first distillation :—	
1000 grains of soil absorbed	·852
According to the second distillation :—	
1000 grains of soil absorbed	·884
The mean of the two direct determinations is	1·101
The mean of the two determinations by distillation is	·868
Difference	·233

An error, amounting to one quarter of the whole of the ammonia absorbed by the soil, would therefore have been committed had the determination not been made after distilling the liquid with caustic potash.

Fifth Experiment, on Pasture Land.

The mechanical analysis of this soil yielded the following results :—

Moisture	2·42
Organic matter	11·70
Lime	1·54
Clay	48·39
Sand	35·95
	100·00

Submitted to chemical analysis it yielded :—

Moisture	2·420
Organic matter	11·700
Oxides of iron and alumina	11·860
Carbonate of lime	1·240
Sulphate of lime	·306
Phosphoric acid	·080
Chloride of sodium	·112
Potash (soluble in acid)	·910
Soluble silica	4·090
Insoluble siliceous matters	67·530
	100·248

3500 grains of this soil were shaken up in a stoppered bottle with 14,000 grains of ammonia solution, and the operation conducted in every respect in the same manner as in the preceding experiments :—

	Ammonia. Grains.
Before contact with soil 1000 grains of solution contained	·332
After contact with soil 1000 grains contained	·071
	·261

Thus, ·261 grains apparently were removed from every 1000 grains of liquid, or 3·654 grains from the whole solution. Accordingly 1000 grains of soil would have absorbed 1·044 grains of ammonia. But in reality the amount of ammonia absorbed by this soil is not so large.

A glance at the foregoing composition of the soil shows that it is rich in vegetable matter. This fully accounts for the deep brown colour which the ammonia solution assumed after contact with the pasture land. It became thus necessary to distil the liquid before determining the ammonia. The following result was obtained by distillation :—

	Ammonia. Grains.
Before contact with soil 1000 grains of liquid contained	·332
After contact " " "	·188
	·144

Therefore ·144 grains of ammonia were removed from every 1000 grains, or 2·016 from the whole solution, and taken up by the soil. 1000 grains of soil accordingly absorbed only ·576 grains of ammonia.

In the preceding experiments the following quantities of ammonia were thus absorbed by 1000 grains of—

	Ammonia. Grains.
1. Calcareous soil	·882
2. Fertile loamy soil and clay subsoil ..	·804
3. Heavy clay soil	·754
4. Sterile sandy soil	·868
5. Pasture land	·576

It is worthy of notice that the sterile sandy soil absorbed as much ammonia as the calcareous clay, and even rather more than the heavy clay soil, thus proving that the property of absorbing ammonia is not confined to clay soils, but that it is shared by light sandy soils.

It has been too generally assumed that sandy soils do not possess the power of retaining any ammonia; but the preceding experiments show unmistakably that this opinion is not founded on fact. If soluble manuring matters were indeed very readily washed out of sandy soils, it is certain top-dressing with nitrate of soda, or sulphate of ammonia and other soluble manures, in nine cases out of ten, would produce little or no effect upon them; for these top-dressings are usually applied at a period of the year when rain falls in abundance, and every facility is afforded for the removal of these soluble matters. Experience, however, teaches us that such top-dressings are particularly valuable on sandy soils, which could not be the case if these did not possess a power ascribed by many persons solely to clay soils. Although it is no doubt the case that heavy rains wash into the drains useful manuring matters, and that clay soils possess in a higher degree the power of retaining fertilizing substances than sandy soils, nevertheless we need not, on the approach of a heavy thunderstorm, be apprehensive that all the sulphate of ammonia or guano which may have been applied to some light sandy land only a few days ago, will be entirely washed away.

Again it may be noticed that the soil taken from the pasture, which abounds in vegetable matter, absorbed the least ammonia. The question naturally arises, Is the cause of this difference due to the presence of organic matter, or to any other peculiarity in this soil? I am unable to answer this question at present, but think it possible that the presence of a large quantity of organic acids in a soil may be unfavourable to the retention of ammonia. Future and extended experiments are needed to confirm or refute this supposition. In the mean time I may direct attention to the well-known fact, that on certain old pasture land ammoniacal manures produce little effect, whereas these manures generally increase the produce of grass in a remarkable manner. In all specimens of soil taken from old pastures, upon which ammoniacal manures have little or no effect, I find a large excess of organic matter. It is just possible that this excess of organic matter prevents the retention of ammonia by the soil; but I have no opinion at present as to the precise mode in which this is effected.

I would also notice specially that the soil employed in the third experiment was the same heavy clay soil which Mr. Mechi kindly sent to me for experimental purposes, and with respect to

which I have published some filtration experiments in Part I., vol. xx. of this Journal. For the latter experiments I used liquid manure, which, in addition to a great number of chemical fertilizing matters, contained only 3·36 grains of ammonia in the imperial gallon. It might certainly have been expected that 20,000 grains of soil would have absorbed this small quantity of ammonia, the absorption even then being only at the rate of ·168 grains of ammonia to 1000 grains of soil. Notwithstanding the large quantity of clay in Mr. Mechi's soil, and the small quantity of ammonia in his liquid manure, only 1·81 grains of ammonia were absorbed by 20,000 grains of soil, and 1·55 grains remained in the liquid after three days' contact with it. In this experiment 1000 grains of soil thus absorbed only ·0905 of a grain of ammonia.

In my remarks on this experiment, I express the opinion that a stronger solution of ammonia passed through Mr. Mechi's soil would have parted with a much larger proportion of ammonia than in this experiment. The proof of this is now given. In the former experiment 1000 grains of this clay soil removed only ·0905 of a grain of ammonia from a very dilute ammoniacal liquid; in the present experiment the same quantity of the same soil absorbed about eight times as much, or ·754 grains of ammonia from the stronger solution, containing 23·24 grains of ammonia per gallon.

It must, however, be remembered, that whereas I employed in my former experiments highly complex liquids, in my present trials simple solutions of caustic ammonia were used. The quantity of ammonia which a soil is capable of absorbing must no doubt depend in some degree on the conditions under which the ammonia is present in the liquid. The preceding experiment is, therefore, not quite conclusive. In order to satisfy myself beyond doubt whether more ammonia is really removed from a stronger than from a weaker solution or not, I instituted a second series of experiments, which I must briefly describe.

Second Series of Absorption Experiments with stronger Ammonia Solutions.

A solution of ammonia in distilled water was prepared, containing about twice as much ammonia as that used in the first series. To speak more exactly, this stronger solution contained 47·11 grains of ammonia per gallon, or ·673 grains of ammonia in 1000 grains of liquid.

The clear ammoniacal solution having been poured off the soil as completely as was possible in each of the five experiments of the first series, the liquid remaining with the soils in the bottles

was weighed, and the amount of ammonia contained in this liquid ascertained in each case by calculation:—

14,000 grains of the stronger solution, containing ·673 grains of ammonia in 1000 of liquid, were now added, and the bottle well agitated several times during the first day, the liquid being afterwards allowed to subside. After three days it became clear. A quantity sufficient for making three or four ammonia determinations was then drawn off in a perfectly clear state.

The amount of ammonia contained in the remainder of the solutions left in the soils from the first series of experiments being known, and likewise the quantity of ammonia added in the stronger solution, the ammonia in the liquid after contact with the soil determined the proportion absorbed from the stronger ammoniacal liquid.

The same plan was adopted in all five experiments, and in each experiment the same quantity of ammonia solution was used.

First Experiment (Calcareous Soil).

	Ammonia. Grains.
Quantity of ammonia left in bottle	·732
,, ,, in 1400 grains of fresh liquid ..	9·422
	10·154

1000 grains of mixed liquid contained ·531 grains of ammonia.

	Ammonia. Grains.
After contact with soil the solution contained in 1000 grains	·431
Before contact with soil it contained	·531
	·100

Consequently ·100 grains were removed from each 1000 grains of liquid, or 1·9120 grains from the entire solution employed in the experiment, and taken up by 3000 grains of soil.

1000 grains of soil thus absorbed ·6373 grains of ammonia, in addition to ·882 grains of ammonia absorbed in the 1st Experiment with a weaker solution.

The total quantity of ammonia taken up by 1000 grains of the soil in the two experiments thus amounts to 1·5193 grains.

Second Experiment (Fertile Loamy Soil).

	Ammonia. Grains.
Quantity of ammonia left in bottle	·437
,, ,, added in fresh solution	9·422
	9·859

1000 grains of mixed solution contained ·554 grains of ammonia.

After contact with the soil the solution contained in 1000 grains ·410 grains, therefore ·144 grains were removed from every 1000

grains of liquid, or 2·5632 grains from the entire solution used in the experiment, and absorbed by 3500 grains of soil; or 1000 grains of soil absorbed ·7323 grains of ammonia, in addition to ·804 grains of ammonia absorbed in the 1st Experiment, thus giving a total of 1·5363 grains of ammonia in both trials.

Third Experiment (Heavy Clay Soil).

	Ammonia. Grains.
Quantity of ammonia left in bottle	·846
,, ,, added in fresh solution	9·442
	10·288
1000 grains of mixed solution contained	·515
After contact with soil 1000 grains of solution contained	·450
	·065

Therefore ·065 grains were removed from every 1000 grains of liquid, or 1·294 grains from the entire solution, and absorbed by 3500 grains of soil.

	Ammonia. Grains.
1000 grains thus absorbed in the 2nd Experiment ..	·3697
And in the 1st Experiment	·7543
Or in both Experiments	1·1240

Fourth Experiment (Sterile Sandy Soil).

	Ammonia. Grains.
Quantity of ammonia left in bottle	·414
,, ,, added in fresh solution	9·442
	9·856
For 1000 grains of mixed solution there was	·562
And after contact with soil	·431
	·131

Thus ·131 grains were removed from every 1000 grains of solution, or 2·290 grains from the entire solution, and taken up by 3500 grains of soil.

	Ammonia. Grains.
1000 grains of soil, therefore, absorbed in 2nd Experiment	·654
And in 1st Experiment	·868
Or in both Experiments	1·522

Fifth Experiment (Pasture Land).

	Ammonia. Grains.
Quantity of ammonia left in bottle	·926
,, ,, added in fresh solution	9·422
	10·348
1000 grains of mixed solution contained	·546
And after contact with the soil	·370
	·176

Therefore ·176 grains were removed from every 1000 grains of liquid of 3·331 grains from the entire quantity of liquid used in the experiment and absorbed by 3500 grains of soil.

	Ammonia. Grains.
1000 grains of this soil thus absorbed in the 2nd Experiment	·9457
After having taken up in the 1st Experiment	·576
Or in both experiments 1000 grains of soil absorbed ..	1·5217

Thus in each case the soils absorbed a considerable quantity of ammonia from the stronger solution with which they were brought into contact after having taken up a certain variable quantity from a weaker solution.

It is singular that whilst the proportion of ammonia removed by each of these five soils varied considerably in the first series of experiments with the weaker ammonia solution, the total quantity of ammonia absorbed by 1000 grains of soil in both experiments is almost identical in four of the soils, and but little less in the remaining one. Thus the total amount of ammonia absorbed by 1000 grains of soil was in the case of the—

	Ammonia. Grains.
1. Calcareous soil	1·5193
2. Fertile loamy soil	1·5363
3. Clay soil	1·1240
4. Sterile sandy soil	1·5220
5. Pasture land	1·5217

It will be seen that the soil from a permanent pasture absorbed much more ammonia in the 2nd Experiment than in the first, so that the total quantity of ammonia absorbed in the two together is nearly identical with that absorbed by the other soils.

I have shown that this soil contained much organic matter (humic acids), and that a portion of this organic matter united with ammonia passed into solution in the 1st Experiment, imparting to it a deep yellow colour. In the 2nd Experiment with a stronger ammonia solution the liquid was but little coloured. It appears thus that, comparatively speaking, little ammonia was fixed in the soil in the 1st Experiment, because the organic acids in this soil uniting with the ammonia of the weaker solution, produced soluble combination before insoluble compounds of ammonia could be formed in the soil in as large a proportion as in the other soils containing much less organic matter.

The organic acids of the pasture soil were apparently removed in the 1st Experiment, and thereby the soil acquired increased powers of absorbing ammonia from the stronger solution used in the 2nd Experiment.

Third Series of Experiments.

Although the preceding experiments show distinctly that soils, no matter of what character, absorb more ammonia from strong

than from weak solutions, and that however weak the solution may be, the total amount of ammonia which it may contain is never wholly absorbed by the soil, it appeared to me desirable to place these facts beyond a doubt by further experiments. I therefore instituted a fresh series, in which one and the same soil was used throughout. This soil was found, on analysis, to contain in 100 parts:—

	Ammonia. Grains.
Moisture	4·72
Organic matter and water of combination	11·03
Oxides of iron	9·98
Alumina	6·06
Carbonate of lime	12·10
Sulphate of lime	·75
Alkalies and magnesia (determined by loss)	1·43
Soluble silica (soluble in dilute caustic potash)	17·93
Insoluble siliceous matter (chiefly clay)	36·00
	100·00

An inspection of the analysis shows that this soil contains a good deal of clay and of carbonate of lime. It is in fact a calcareous clay, of a moderately stiff and retentive physical character.

Four solutions of caustic ammonia in distilled water were carefully prepared:—

	Grains of Ammonia per Gallon.		Per 1000 Grains.
Solution No. 1 contained	44·38	or	·634
,, No. 2 ,,	21·28	or	·304
,, No. 3 ,,	12·32	or	·176
,, No. 4 ,,	6·16	or	·088

In each experiment 7000 grains of the respective liquids were repeatedly agitated in a tight-fitting glass-stoppered bottle, with ¼ lb. of soil. The liquid was then allowed to subside for four days, after which time it became perfectly clear. The ammonia in the clear liquids was then determined by the process described in the preceding pages, and the following results were obtained:—

1.—*Experiment with Solution No.* 1.

	Ammonia. Grains.
Before contact with soil the solution contained	4·438
After contact ,, ,, ,,	2·128
	2·310

Therefore 2·310 grains of ammonia were absorbed by 1750 grains of soil, or 1000 grains absorbed 1·32 grains of ammonia.

2.—*Experiment with Solution No.* 2.

		Ammonia. Grains.
Before contact with soil the solution contained	.. ..	2·128
After contact ,, ,,	.. ..	1·008
		1·120

Therefore 1·120 grains of ammonia were absorbed by 1750 grains of soil, or 1000 grains absorbed ·64 grains of ammonia.

3.—*Experiment with Solution No.* 3.

		Ammonia. Grains.
Before contact with soil the solution contained	.. ..	1·232
After contact ,, ,,	.. ..	·777
		·455

Thus ·455 grains of ammonia were absorbed by 1750 grains of soil, or 1000 grains absorbed ·26 grains of ammonia.

4.—*Experiment with Solution No.* 4.

Before contact with soil the solution contained	.. ..	·616
After contact ,, ,,	.. ..	·441
		·175

Therefore ·175 grains of ammonia were absorbed by 1750 grains of soil, or 1000 grains of soil absorbed ·100 grains of ammonia.

According to the strength of the different solutions 1000 grains of soil thus absorbed in—

	Ammonia. Grains.
No. 1	1·32
No. 2	·64
No. 3	·26
No. 4	·10

Not only is the absolute quantity of ammonia which this soil absorbs from an ammoniacal solution larger as the solution employed is stronger; but very dilute solutions are relatively less exhausted by it than stronger ones.

Thus, whilst in the two first experiments, in round numbers, one-half of the ammonia contained in the solutions was absorbed, in the 3rd Experiment about one-third, and in the 4th only about one-fourth of the ammonia was retained by the soil.

In the next place I made some additional experiments for the purpose of ascertaining whether this soil, after having taken up as much ammonia as it will from a weaker solution, would take up more from a stronger one.

Experiment 5.

The solution left in the bottle from Experiment No. 2 was drawn off as much as possible, the liquid remaining with the soil was

ascertained by weighing, the amount of ammonia in it calculated, and 7000 grains of solution No. 1, containing 4·438 grains of ammonia added.

The quantity of liquid left in the bottle was 2070 grains, and contained ·298 grains of ammonia, the fresh quantity of stronger solution added 7000 grains, containing 4·438 grains.

The total solution weighed 9070 grains, and contained 4·736 grains of ammonia; 1000 grains of this solution, therefore, contained ·522 grains of ammonia. After standing for four days, the liquid was drawn off and the strength determined as before. This solution contained ·320 grains of ammonia.

	Ammonia. Grains.
Before contact with soil 1000 grains of solution contained	·522
After contact ,, ,, ,, ..	·320
	·202

Thus ·202 grains of ammonia were removed from every 1000 grains of solution. From the whole solution (weighing 9070 grains) consequently 1·83214 were removed and retained by the soil (1750 grains), which had already taken up 1·120 grains from the weaker solution.

	Ammonia. Grains.
1000 grains of soil therefore absorbed in the 2nd Experiment	1·047
And had previously absorbed	·640
	1·687

Or 1000 grains of soil absorbed from both solutions 1·687 grains of ammonia.

In a similar manner the following experiments were made:—

Experiment 6.

There was added to the contents of the bottle used in Experiment No. 3, 5000 grains of solution No. 2, containing ·304 grains ammonia in 1000 of liquid.

	Ammonia. Grains.
Before contact with soil 1000 grains of the mixed solutions contained	·237
After contact with soil 1000 grains of the solution contained	·127
	·110

Therefore ·110 grains were removed from every 1000 grains of liquid, or ·836 grains from entire solution, and retained by 1750 grains of soil, which had already taken up ·455 grains from the weaker solution. 1000 grains of soil therefore absorbed in 2nd Experiment ·477 grains, in addition to ·260 grains absorbed from the weaker solution, or from both solutions ·737 grains of ammonia were removed and retained by 1000 grains of soil.

Experiment 7.

The solution left in the bottle from Experiment No. 4 was drawn off as thoroughly as possible; 7000 grains of solution No. 3, containing ·176 grains of ammonia in 1000 of liquid, were then added, and after repeated shakings the whole was left to settle for four days.

	Ammonia. Grains.
Before contact with soil 1000 grains of the mixed solutions contained	·147
After contact with soil 1000 grains of the solution contained	·096
	·051

Therefore ·051 grains of ammonia were removed from every 1000 grains of liquid, or ·480 grains from the whole solution, and retained by 1750 grains of soil, which had already taken up ·175 grains of ammonia from the weaker solution.

	Ammonia. Grains.
1000 grains of soil thus absorbed from the weakest solution	·100
From the stronger solution	·274
	·374

Or in both experiments ·374 grains were removed and retained by 1000 grains of soil.

Thus in all cases much more ammonia was removed from the stronger solutions than from the weaker, and was retained by the soil in addition to the quantity previously absorbed from the weaker solution. Thus the total amount of ammonia absorbed by 1000 grains of soil was in—

	Ammonia. Grains.
Experiment No. 5	1·687
,, No. 6	·737
,, No. 7	·374

It will be observed that in Experiment No. 1, 1000 grains of soil removed 1·32 grains of ammonia from the strongest solution. The same solution, taken in the same quantity as in Experiment No. 1, and left in contact with soil which had already absorbed ·64 grains of ammonia, removed an additional quantity of 1·047 grains, or altogether 1·687 grains.

It thus appears not only that the strength of the solution influences the amount of ammonia which can be retained by the soil, but likewise that the quantity of liquid which is passed through a soil will affect the proportion which a soil is capable of abstracting from a given solution.

From a *large quantity* of an ammoniacal liquid it appears to

me likely that a definite quantity of soil will remove more ammonia than from a smaller amount of liquid of the same strength.

I have not, as yet, made many experiments in this direction. These are urgently needed, for it is clear that we cannot calculate with any degree of certainty the amount of loss in ammonia to which ammoniacal manures are subject in contact with soil, as long as we are not fully acquainted with the exact conditions under which this most interesting chemical property of soils manifests itself.

Fifth Series.—Ammonia Retention Experiments.

In the preceding experiments it has been shown that all the soils experimented upon possess the power of absorbing ammonia; further, that all the soils absorbed more ammonia from a more concentrated than from a weaker solution; and, lastly, that in no instance was the ammonia entirely removed from a solution brought into intimate contact with soil. Even in the case of heavy clay soils, and when very dilute ammoniacal solutions were employed, ammonia invariably remained in solution. These facts not only explain the different results which must be obtained in experimenting upon the same kind of soil with solutions of different strength, but they also prove incontestably that the compounds which, no doubt, are produced in almost every description of soil, when ammoniacal solutions are brought into contact with them, are not entirely insoluble, as has been supposed, but sufficiently soluble in water to benefit the growing crops, which we have no reason to suppose take up food from the soil in any other than a soluble state.

Notwithstanding the power of soils to absorb ammonia, this fertilizing constituent is not fixed by the soil so completely or permanently as to be of no avail to the growing plant. The possibility also exists that long-continued and heavy rains may wash out more or less completely the ammonia previously absorbed by soils. Hence the invariable presence of ammonia in spring waters.

An important question is naturally started by these curious properties of soils. It is this: Is the power of soils to retain ammonia greater, and if so to what extent, than the tendency to yield it again to water passed through the soil?

In order to facilitate the solution of this question I instituted a Fifth Series of Experiments, which, under the title of "Ammonia Retention Experiments," I shall now endeavour briefly to describe.

The soil used in these experiments was the same as that employed in the Fourth Series.

1*st Experiment.*—A strong solution of pure ammonia in distilled water was prepared, and its strength accurately determined. An imperial gallon contained 194·39 grains of ammonia, or 1000 grains 2·777 grains. ¼ lb. soil (1750 grains) was placed in a well-stoppered bottle, and 7000 grains of the ammonia solution of the above strength were added. The bottle and contents were repeatedly shaken, and then the whole left to subside for three days. The clear liquid was drawn off and weighed, and its strength determined in the usual way.

	Ammonia. Grains.
Before contact with the soil 1000 grains of the solution contained	2·777
After contact	2·112
	·665

Thus ·665 grains of ammonia were removed from every 1000 grains of solution, or 4·655 grains were removed from the whole solution employed (7000 grains) and retained by 1750 grains of soil. 1000 grains of soil consequently absorbed 2·66 grains of ammonia. The quantity of liquid drawn off weighed 4916 grains, and contained 10·382 grains of ammonia.

The residue in the bottle was next shaken up with 7000 grains of distilled water; after three days the clear liquid was drawn off, weighed, and its strength determined as before. 1000 grains of the liquid were found to contain ·510 grains of ammonia. The amount of liquid left in the bottle before the addition of 7000 grains of water, and its strength, being known, this result will show whether or not the addition of water has had any effect upon the ammonia retained by the soil from a strong ammoniacal solution.

Had the effect of the water simply resulted in the dilution of the ammonia-solution, which could not be poured off from the soil in a clear state, its strength would have been ·484 grains of ammonia in every 1000 grains; but it was ·510 grains of ammonia, consequently ·026 grains of ammonia were removed by every 1000 grains of liquid, or ·236 grains by the whole quantity of liquid employed in the experiment, from 4·655 grains of ammonia previously absorbed by ¼ lb. of soil.

2*nd Experiment.*—7000 grains of distilled water were added to the residue in the bottle from the preceding experiment, and after three days the clear liquid was drawn off, weighed, and the strength determined. 1000 grains of liquid contained ·192 grains. If this second addition of water had not acted upon the

ammonia absorbed by the soil in the preceding experiment, 1000 grains of liquid would have contained ·121 of ammonia; consequently ·071 of ammonia were extracted by every 1000 grains of liquid, or ·642 grains by the whole liquid, from the ammonia which the soil retained after having been once washed with 7000 grains of water.

3rd Experiment.—7000 grains of distilled water were added to the residue left in bottle from the 2nd Experiment, and treated as before. 1000 grains of clear liquid contained ·111 grains of ammonia. If no ammonia had been extracted by this third addition of water, 1000 grains of liquid would have contained ·044 of ammonia, instead of ·111 grains; consequently ·067 grains of ammonia were extracted by every 1000 grains, or ·61 grains by the whole liquid from the soil, after having been washed twice before with water.

4th Experiment.—To the residue left in bottle from 3rd Experiment 7000 grains of distilled water were again added, and the bottle put aside for two months. After that time the clear liquid was drawn off, weighed, and its strength determined. 1000 grains of liquid contained ·096 grains of ammonia. Had no ammonia been extracted from the soil it would have contained ·037 grains of ammonia in 1000 grains; accordingly ·059 of ammonia were extracted by every 1000 grains of liquid, or ·622 grains by the entire liquid. This quantity, it will be observed, is almost identical with that extracted in the 3rd Experiment.

5th Experiment.—After a fresh addition of 7000 grains of distilled water, 1000 grains of liquid contained ·040 grains of ammonia. Had no ammonia been extracted from the soil it would have contained ·028 grains; therefore ·012 grains were extracted by every 1000 grains of liquid, or ·120 grains by the entire solution.

6th Experiment.—After a fresh addition of 7000 grains of distilled water 1000 grains of liquid contained ·029 grains of ammonia. If no ammonia had been extracted 1000 grains of liquid would have contained ·006 grains; therefore ·023 grains of ammonia were extracted by every 1000 grains, or ·193 grains by the entire quantity of liquid.

7th Experiment.—7000 grains of distilled water were, for the seventh time, added to the residue left in the bottle from the 6th Experiment, and treated as before. 1000 grains of liquid contained ·031 grains of ammonia. Had no ammonia been extracted they would have contained ·005 grains of ammonia; thus ·026 grains of ammonia were extracted from the soil by every 1000 grains, or ·228 grains from the entire liquid.

Let us then add up the quantities of ammonia removed by these successive washings with water:—

Experiment.		Ammonia. Grains.
1st.	Removed by 7000 grains of water	·236
2nd.	,, ,, ...	·642
3rd.	,, ,, ...	·610
4th.	,, ,, ...	·622
5th.	,, ,, ...	·120
6th.	,, ,, ...	·193
7th.	,, ,, ...	·228
	Total	2·651

Thus ·2651 grains of ammonia were removed by 49,000 grains of water from ¼ lb. of soil. This quantity of soil absorbed from a strong ammoniacal solution 4·655 grains of ammonia. By deducting 2·651 grains of ammonia, *i. e.* the amount washed out by seven successive washings, with 7000 grains of water each, we obtain 2·004 as the quantity of ammonia which was retained by the soil, after all the washings with water.

More than half the ammonia originally absorbed by the soil was thus again removed by washing with water.

It appears thus distinctly that the *power of soils to remove ammonia from solutions is very much greater than their property of yielding it again to water.*

Indeed even a very much larger quantity of water than that which falls annually upon our fields in the shape of rain is incapable of washing out of the soil such a proportion of ammonia, as can be of any account in relation to the quantities incorporated with it in the shape of natural or artificial manures. In the experiments before us the weight of water which was passed through the soil was twenty-eight times as large as the weight of the soil, and yet little more than half the quantity of ammonia absorbed by the latter was extracted by this immense amount of water. In nature such excessive washings by rain are not likely to occur; we need not therefore fear that the ammonia absorbed by the soil we cultivate will be removed by the most heavy rain-storms to anything like the extent in which it was removed in my experiments.

At the same time it is well to remember that each shower of rain renders soluble some ammonia which may have been previously absorbed by the soil. The best fertilizing matters, if presented to plants in great abundance, exercise an injurious effect upon their growth, or, at any rate, favour an unhealthy development of one part of the vegetable organism at the expense of another. Thus wheat or barley grown on a dung-heap becomes rank and attains a great size, but will hardly flower, and never produce any grain. This is accounted for by the fact that farm-yard manure contains far too much soluble manuring matters to be beneficial to the healthy development of the crops which we cultivate.

It is one of the functions of soils to check the accumulation of soluble fertilizing matters, and this function it performs in many instances by rendering insoluble, or, to speak more correctly, by greatly reducing the solubility of those important fertilizing matters which would otherwise induce an unhealthy or abnormal growth of plants. Considering the structure of the spongioles of the roots of plants we readily comprehend how important it is that such matter should be able to find its way into the vegetable organism. Whilst thus it is the particular function of the soil to prevent the loss of ammonia from manures, such as guano, sulphate of ammonia, &c., which we are in the habit of applying to the land, provision is made that the ammonia, when it becomes fixed by the soil, should not be rendered so entirely insoluble as to be of no direct benefit to plants.

In short, all soils, clay as well as sand, store up ammonia with great eagerness, and part with it reluctantly.

Sixth Series.—Absorption of Ammonia from a Solution containing Chloride of Ammonium.

In this series of experiments I endeavoured to ascertain the amount of ammonia which soils of known composition absorb from a standard solution of sal-ammoniac in water.

The solution used in the following experiment contained 79·80 grains of chloride of ammonium in the imperial gallon, or 25·20 grains of ammonia; or 1000 grains of this solution contained 1·14 grains of chloride of ammonium, or ·36 grains of ammonia.

The soils experimented upon were the same as those used in the First Series of Experiments, namely :—

1. A calcareous clay.
2. A fertile loam.
3. Stiff clay soil.
4. Sterile sandy soil.
5. Pasture land.

In each case 3500 grains of soil were mixed with 14,000 grains of a solution of chloride of ammonium, containing ·36 grains of ammonia in 1000 grains of liquid. After standing three days the clear liquid was drawn off, and the ammonia contained in it obtained by distillation with caustic potash. The operation was conducted in each case alike, and the following results were obtained :—

	Ammonia. Grains.
No. 1. 1000 grains of soil absorbed	·68
No. 2. ,, ,, ...	·76
No. 3. ,, ,, ...	·80
No. 4. ,, ,, ...	·16
No. 5. ,, ,, ...	·64

It will be noticed that the proportions of ammonia which are absorbed by the five different soils from a solution of sal-ammoniac, containing 79·80 grains of this salt in an imperial gallon, vary considerably.

In the case of the sandy soil very little ammonia indeed was absorbed. This is rather singular, since the same sandy soil absorbed a good deal of ammonia on being brought into contact with a dilute solution of free ammonia.

We thus see that a soil may absorb free ammonia in considerable quantities, and yet not have the power of separating and fixing ammonia from an ammoniacal salt, such as sal-ammoniac.

Seventh Series.—Absorption of Ammonia from a Solution of Sulphate of Ammonia.

A solution of sulphate of ammonia was prepared, containing 77·70 grains of sulphate of ammonia per imperial gallon, or 20·16 grains of ammonia. 1000 grains of liquid therefore contained ·288 grains of ammonia. The same soil was used in this as in the preceding Series of Experiments. In each case 3500 grains of soil were shaken up in a well-stoppered bottle with 14,000 grains of the solution of the above strength. In these experiments—

	Ammonia. Grains.
No. 1. 1000 grains of soil absorbed	·608
No. 2. ,, ,, ...	·640
No. 3. ,, ,, ...	·576
No. 4. ,, ,, ...	·256
No. 5. ,, ,, ...	·448

Here again the sandy soil absorbed but very little ammonia. There seems thus to be something or other wanting in this soil which prevents it from exercising a decomposing influence upon ammoniacal salts similar to that manifested by the four other soils. I am informed that farmyard manure, guano, and other fertilizers of recognized value, produce little effect upon the crops growing on this sterile sandy soil.

Eighth Series.—Retention of Ammonia from a Solution of Sulphate of Ammonia.

In the Fifth Series of experiments I have shown that a soil which absorbed a certain quantity of free ammonia from a tolerably strong solution with which it was brought into contact, again yielded small quantities of ammonia to repeated washings of distilled water.

It appeared to me desirable to ascertain whether similar results would be obtained on washing a soil which had absorbed a certain quantity of ammonia from a solution of sulphate of ammonia.

To this end, I prepared a solution of sulphate of ammonia, which contained 188·720 grains of ammonia in the gallon, or 2·696 grains of ammonia in 1000 grains of liquid. ¼ lb. (1750 grains) of calcareous soil used in First Series was mixed in a stoppered bottle with 7000 grains of this solution, then left at rest for three days, after which the clear liquid was drawn off, and the ammonia contained in it determined by distillation :—

	Ammonia. Grains.
Before contact with soil 1000 grains of solution contained ..	2·696
After contact " " "	2·000
	·696

Therefore ·696 grains of ammonia were removed from every 1000 grains of liquid, or 4·872 grains were removed from the whole solution, and retained by 1750 grains of soil; 1000 grains of soil thus absorbed 2·784 grains of ammonia.

A comparison of this result with the amount of ammonia absorbed from sulphate of ammonia in the preceding experiments, shows that much more ammonia is removed by soil from the stronger ammoniacal solution than from the weaker one.

The liquid was drawn off as much as possible, and the amount of that which could not be removed ascertained by weight; 7000 grains of pure distilled water were next added; after three days the clear liquid was drawn off and weighed, and the ammonia in it determined by distillation in the usual way.

Proceeding in this manner, the soil which had absorbed 4·872 grains of ammonia from a strong solution of sulphate of ammonia was washed five times with 7000 grains of water each time :—

	Ammonia. Grains.
The first washing removed	·278
The second ,, ,, ...	·633
The third ,, ,, ...	·813
The fourth ,, ,, ...	·416
The fifth ,, ,, ...	·242
	2·382

35,000 grains of water, or ½ gallon, thus removed 2·382 grains of ammonia from the soil, which had absorbed 4·872 grains of ammonia. At the conclusion of the experiment the quantity of ammonia which remained in ¼ lb. of soil amounted to 2·490 grains, or very nearly half the quantity which it absorbed in the first place.

These results are conformable with those obtained in the Retention Experiments, where a solution of free ammonia was employed.

Ninth Series.—Retention of Ammonia from a Solution of Chloride of Ammonium.

The soil used in this series of experiments was the same as that employed in the Third Series.

The solution of sal-ammoniac contained 211·40 grains of ammonia in the gallon, or 3·02 grains in 1000 of liquid. ¼ lb. of soil and 7000 grains of solution of sal-ammoniac of this strength, were mixed together, and the amount of ammonia absorbed by the soil ascertained as before. The whole quantity of soil absorbed in this experiment 5·60 grains of ammonia. 1000 grains thus separated 3·20 grains of ammonia from the solution of sal-ammoniac.

Here again we observe that the amount of ammonia which a soil is capable of removing from solutions of ammoniacal salts depends upon the strength of the liquid with which it is brought into contact.

The soil was next washed four times with 7000 grains of water, and the proportion of ammonia removed in each washing determined as before:—

	Ammonia. Grains.
The first washing removed	·409
The second ,, ,, ...	·646
The third ,, ,, ...	·811
The fourth ,, ,, ...	·499
	2·365

28,000 grains of water thus removed 2·365 grains of ammonia from ¼ lb. of soil, which in the first place absorbed 5·60 grains of ammonia from a strong solution of sal-ammoniac. After washing with a considerable quantity of water, the soil thus retained 3·235 grains of ammonia, instead of 5·60 grains.

Thus, whether a soil has absorbed free ammonia, or ammonia from a solution of sulphate of ammonia or sal-ammoniac, water passed through it will wash out a certain quantity of ammonia. But in each case the power of a soil to retain ammonia is very much greater than its inclination to yield it again to water.

It is hardly necessary to remind the reader that in the absorption experiments with salts of ammonia the acid of the salt passes through the soil in combination with lime or other mineral matters of the soil, whilst the ammonia alone is retained. I may notice, however, that the watery liquid which passes through a soil when solutions of ammoniacal salts are filtered through it, contains a larger quantity of *mineral* matters than is the case when *pure* water is filtered through the soil. It would thus appear that ammoniacal salts have the property of rendering the mineral matters of the soil soluble. But the details of experiments on this subject, and an account of their bearing on agriculture, must be reserved for a future communication.

In conclusion, the more prominent and practically interesting points which have been developed in the preceding pages may be briefly stated in the following

SUMMARY.

1. All the soils experimented upon have the power of absorbing ammonia from its solution in water.

2. The sandy soil absorbed as much ammonia as the clay soil.

3. The pasture land, and probably many other soils rich in organic matter, retain less ammonia than soils in which organic matter does not occur in excess.

4. The differences between sandy, calcareous, and clay soils, in their power of absorbing ammonia, is not so great as is generally believed.

5. Ammonia is never completely removed from its solution, however weak it may be. On passing a solution of ammonia, whether weak or strong, through any kind of soil, a certain quantity of ammonia invariably passes through. No soil has the power of fixing completely the ammonia with which it is brought into contact.

6. In the preceding experiments all the soils absorbed more ammonia from the stronger than from the weaker solution; that is to say, the absolute quantity of ammonia which is absorbed by a soil is larger when a stronger solution of ammonia is passed through it. But, relatively, weaker solutions are more thoroughly exhausted than stronger ones.

7. Soils containing much organic matter (humic acids) at first absorb less ammonia from weak solutions than others poor in vegetable matter. But subsequently they take up more ammonia if it is presented to them in stronger solutions.

8. A soil which has absorbed as much ammonia as it will from a weak solution, takes up a fresh quantity of ammonia when it is brought into contact with a stronger ammoniacal solution.

9. All the soils not only absorbed free ammonia, but likewise removed a certain quantity from solutions of ammoniacal salts.

10. In passing sulphate of ammonia or sal-ammoniac through a soil, the ammonia alone is absorbed, and the acids pass through in combination with lime or other mineral matters.

11. A larger proportion of mineral matter is dissolved in a soil when dilute solutions of ammoniacal salts are filtered through it than is the case with pure water.

12. Soils absorb more ammonia from stronger than weaker solutions of sulphate of ammonia and chloride of ammonium.

13. Not only the *strength*, but likewise the *quantity* of the ammoniacal solution which is brought into contact with a soil,

appears to influence the amount of ammonia which the latter is capable of retaining.

14. In no instance is the ammonia absorbed by soils from solutions of free ammonia, or from ammoniacal salts, so completely or permanently fixed, as to prevent water from washing out appreciable quantities of the ammonia.

15. The proportion of ammonia, however, which is removed in the several washings, is small in proportion to that retained by the soil.

16. *The power of soils to absorb ammonia from solutions of free ammonia, or from solutions of sulphate of ammonia or chloride of ammonium, is thus greater than the power of water to redissolve it.*

17. In practice no fear need be entertained that in ordinary years heavy showers of rain will remove much ammonia from ammoniacal top-dressings, such as sulphate of ammonia, soot, guano, and similar manures, which are used by farmers for wheat, barley, and oats.

18. On the other hand, in very rainy seasons, appreciable quantities of ammonia may be removed from land top-dressed with ammoniacal manures, even in the case of stiff clay soils.

Royal Agricultural College, Cirencester,
June, 1860.

VIII.—*The Drainage of Whittlesea Mere.* By W. Wells.

At various intervals within recent years there have appeared, either as articles in this Journal or as independent works, notices bearing more or less directly on the subject of the large tract of country known as the Great Level of the Fens.

Some of these notices have been most ably written, and have taken comprehensive and scientific views of the nature of the Fens, of the past and present systems of draining and cultivating them, and of the large question of their general improvement, as contrasted or going hand in hand with the marvellous strides that have been made of late years in the cultivation of what a fenman would call the Upper Country.

It has been suggested that, as a sequel to the notices alluded to above, or rather as an illustration of the subjects which they have treated in a general and comprehensive manner, a short account of the draining of Whittlesea Mere would be appropriate and not uninteresting; and it is hoped that although no great addition to the details of scientific or practical agriculture can be offered in giving this account, it will yet be considered that a record of the blotting out from the map of England of one

of its largest inland sheets of water, and of the conversion of its bed into the site of thriving farms, as well as of the operations now being carried on for the reclamation of the peat-bog which surrounded the Mere, may fairly claim a place in the pages of the chief agricultural journal of the country.

To those whose attention has not been directed to the subject of the Fens it may be as well to observe shortly, that the Great Level of the Fens—that is to say, the great district of low country beginning near Ely in Cambridgeshire and extending to the Witham in Lincolnshire, containing in round numbers something like 750,000 acres, comprehends and is nearly synterminous with the so-called Bedford Level, a name given to a vast tract of fen-country, which in the reign of Charles II. was placed for purposes of reclamation and drainage under the control of certain individuals, forming a corporate body, of which the Earl of Bedford was the chairman.

At a later period this Bedford Level became subdivided into three smaller levels, which bear respectively the names of the North, Middle, and South Levels; and it was in the Middle Level—we happily speak of it now in the past tense—that, in advertising phraseology, that well-known fresh-water lake Whittlesea Mere was situated.

On arriving from the south by the Great Northern Railway at a point within five miles of Peterborough, the chimney of the steam-engine, which now maintains the drainage of the Mere and surrounding district, is plainly visible three miles off toward the east. The steam-engine is placed at the easternmost corner of the Mere, which formerly extended thence in the shape of a blunted crescent, the convex side being towards the north, to within half a mile of the spot we suppose the traveller to be passing.

Of the possible readers of this paper not a few may call to mind excursions from Cambridge to the Mere, with either boating or skating intentions. The occasions of the Mere being frozen over were always held as a jubilee by the whole country side. Stalls were erected, bands of music played, and the scene presented all the appearance of a large fair. The best skaters from all parts of the Fens assembled, and putting on their "pattens," as the skates are locally named, decided the claims of districts or individuals to skating superiority.

Whittlesea Mere, in its ancient state, comprised 1600 acres, but at the time when the works for its draining were commenced the ordinary water-acreage had diminished to little more than 1000 acres. Around the shores a margin of silty deposit had been formed, which, though often dry, was liable to submersion upon the slightest rise of the water in the Mere.

Beyond this margin of silt, which varied in breadth from 50 to 500 yards, and was valuable from the excellent reeds it grew, there extended, especially towards the south and west, where the level of the surrounding land was lowest, a large tract of peat-moss, which, though generally free from water during summer, was constantly flooded in winter. On the north and east sides the level of the surrounding land was higher—sufficiently high indeed to be cultivated by the aid of windmills, and, approaching more nearly to the borders of the Mere, left less room for either the inner circle of silty reed-shoal, or for the outer circle of peat-moss.

In addition to the area contained in the Mere, the reed-shoals, and the peat-bog, there was much adjoining low land, more or less under cultivation, which would naturally be included in any scheme for the draining of the water and waste land on which they bordered.

At different times various schemes had been suggested for draining this district, but none had ever reached a state of maturity. One by Sir John Rennie attracted considerable attention at the time. The chief feature of this was the draining by the river Nene, which bounds the Middle Level on the north, as the Ouse, by which the present drainage is effected, bounds it on the south. At first sight the Nene appeared the natural outlet for the waters of the Mere, but there were reasons against its selection, among which it may be sufficient to notice that, besides moral difficulties, which then, as now perhaps, seem to be connected with the outfall at Wisbeach, the point of discharge was too far from the sea, and would be liable to the overriding of the freshes or upland floods.*

In 1839 notice was given of an intention to apply to Parliament for a Bill to enable the owners of lands in and around Whittlesea Mere to drain that district. The design remained for some time in abeyance, in consequence of the Nene scheme having in the meanwhile been brought forward. When the latter scheme was abandoned, a fresh application to Parliament was notified, but withdrawn in deference to the wishes of many landowners in the Middle Level, who proposed that an application to Parliament should be made in behalf of the Level generally, for the enlargement of the powers of the existing Middle Level Act, so as to combine with the draining of the Mere and

* This paper would be incomplete if the opportunity were not taken of recording the name of one individual with whom the scheme for the drainage of the Mere originated, and upon whom subsequently devolved the carrying out all the works of improvement. The name of Mr. John Laurance of Elton will long be remembered in connexion not only with the draining of Whittlesea Mere, but also with many other public and private works in the Fens, in which he has taken an active part.

district around it a general improvement of the whole Level, by rendering the rivers therein more capable of receiving and carrying the upland waters from the Mere and its neighbourhood.

After some delay a general measure was agreed upon, and resulted in the Middle Level Act of 1844; under the large powers of which Act, enabling lands in the Level to be taxed for purposes of drainage, a sum of 200,000*l.* was raised to carry out the contemplated works; and under a subsequent Act a further sum of 230,000*l.* has been expended.

It will be unnecessary to describe these works further than to say that the principal feature was that the point of discharge for the waters of the Middle Level was brought some 6 miles farther down the river Ouse than heretofore, and that a corresponding fall of 6 feet was obtained. This was obtained by means of a noble cut 11 miles long, 40 feet wide at bottom, with an average width of 70 feet at top, and terminating with appropriate sluices, so constructed as to allow advantage to be taken of the still further increase of fall, which it was with just foresight considered would be gained on the completion of even a part of the works contemplated by the promotion of the Norfolk Estuary scheme.

These great works of improvement, however, had not as direct a bearing as could have been desired on the draining of the Mere and the adjacent land, for which, notwithstanding the largely-increased fall that was obtained, a natural drainage was not and cannot under any probable circumstances be obtained. Unluckily the interests of navigation had to be considered in determining the question of the height at which the water, by means of the outfall sluice, should be maintained throughout the country, and the height so determined on in the Act, as the level of the water in summer, is such as to necessitate the lifting up to this navigation-level, by means of machinery, the drainage-waters of the Mere and low lands adjoining. During winter the Act forbids the water to be held up at all in case of flood, and full advantage is taken at the sluices of each low tide.

Preparations were immediately made for discharging the water of the Mere and the surrounding district into the rivers destined to carry them to the outfall in the Ouse, whenever the works in the Level should be reported as sufficiently advanced; and in the summer of 1851 the great Marshland Cut and other principal drains had been so far constructed or enlarged that the moment for emptying the Lake, as it was often called, had arrived; and accordingly a point nearest to one of the exterior rivers having been chosen, the bank was cut through, and the long pent-up waters allowed free passage to the sea.

This may appear to be at variance with what has been said above—that no natural drainage was afforded to Whittlesea Mere

by the new works. The explanation of the apparent contradiction is easy, by contrasting the relative condition of the Mere and the Middle Level at the moment of the main drains being completed, and at a later period when the bottom of the Mere and the adjoining land had been for some time dry. The old state of things was this :—For purposes of navigation a minimum height of 10 feet of water was maintained throughout the Level; that is to say, 10 feet above the low-water-mark gauge in the Ouse at Lynn Bridge, from which all the calculations as to the height of the water in the Middle Level are taken. The bottom of the Mere being 7 feet above the gauge, there remained 3 feet as its ordinary depth of water. When the great Marshland Cut was opened, and the connecting dykes up to the Mere deepened, the water throughout the Level was reduced to 5 feet on the gauge, giving therefore a fall of 2 feet from the bottom of the Mere. This was quite sufficient to create a free flow of the waters by the new passage or cutting through the bank, and accordingly for many days the stream continued to discharge itself into the exterior river. At no time after the first twenty-four hours was there any rush or torrent, but as the weight of water behind diminished, the current became less and less rapid, until at the end of three weeks a sluggish stream was with difficulty maintained through the shoals to the place of exit. Fortunately a favourable wind prevailed, and assisted materially in propelling the water over the higher ground which existed between the point of discharge and the low places in the middle of the lake where the water lingered the longest.

This outpouring of the contents of the Mere then was doubtless so far a natural drainage, but the winter-level rose frequently to 10 feet on the gauge, so that but for the surrounding banks the old 3 feet of water would soon have returned to its accustomed place.

The present state of things is this :—The bed of the Mere has sunk from being 7 feet above datum (the gauge at Lynn) to 3 feet 6 inches ; from this, as the least depth that is consistent with the proper cultivation of soil, 2 feet must be taken, leaving 1 foot 6 inches as the corresponding level on the gauge ; and as the water is held up in summer to 5 feet 6 inches for navigation, and cannot in winter be run lower than about 4 feet 6 inches even with the additional fall obtained by the Norfolk Estuary works, it will be readily seen that it is hopeless to expect ever to obtain a natural drainage for the Mere and the surrounding land.

Long before the last pools of water had disappeared from off the bed of the Mere large crowds of people from all the surrounding neighbourhood, and even many from distant parts of the Fens, had assembled. Some perhaps from a desire to be present at the last moments of a venerable friend whose fortunes

were now reduced to the lowest ebb: others perhaps with whom the love of stewed eels preponderated over sentiment, from the prospect of a ready and abundant gratification of their taste. Of the hundreds—it would be no exaggeration probably to say thousands—who had assembled, nine out of ten came provided with sacks and baskets to carry off their share of the vast number of fish, which, wherever the eye turned, were floundering in the ever-decreasing water. Some more ambitious speculators brought their carts, and gathering the fish by the ton weight, despatched them for sale to Birmingham and Manchester. Contrary to expectation, no fish of very great size was taken; the largest ascertained was a pike of 22 lbs.

So deep and tenacious was the mud, that even with boards attached to the soles of the shoe, it was a matter of extreme labour to move about; and an undue anxiety to seize a lively eel or vigorous jack was sure to lead to an irrecoverable downfall, or to a set-fast in some ungainly position. It is impossible to imagine a more singular scene, and as the fading light of a blood-red sunset fell on the vast multitudes of figures scattered in all directions over the dreary waste of slimy ooze, it left on the mind the same sort of impression of the supernatural as is left by some of Martin's ambitious pictures.

Among the many novelties in the exhibition of 1851 the model of the now well-known Appold Pump attracted the attention of the promoters of the draining of Whittlesea Mere, and after some encouraging conferences on the subject with Messrs. Easton and Amos, it was determined to erect one at a spot suitable for maintaining the drainage of the district; and by the middle of December in the same year, a 25-horse engine and an Appold pump were ready for use. It was calculated that the pump would lift 16,000 gallons a minute with a 6-foot lift, and of course more in proportion as the height of the lift was decreased. Nor was it long before this calculation was put to an unexpectedly severe test.

The summer after the completion of the engine was actively employed in shaping the unbroken expanse of mud into something like an agricultural tract. Dykes were made—roads marked out—boundaries of farms arranged, and in some cases the terms for letting the embryo farms actually agreed upon. Everything looked promising for the future well-being of the new-born district, when, on the 12th of November, the water in the outer rivers being swollen by heavy rains, and pressing against the newly-formed banks with a force they were unable to withstand, a breach was made, and in a few hours Whittlesea Mere was itself again.

Disheartening as was this untoward event, it showed—at the least calamitous moment that it could have occurred—where the weak point was; it necessitated the testing to the utmost the

powers of the engine and pump, and it resulted in perfect confidence being felt that it was master of the situation.

It was reckoned that 1000 acres were covered again with water to a depth of 2 feet 6 inches, and that if the pump could raise 20,000 gallons a minute, it would take twenty-three days incessant pumping to clear off that amount. This calculation proved correct, and in little more than three weeks the land, but certainly not *terra firma*, was again everywhere visible.

The banks having been repaired and fortified, the work of reclamation, and preparing for the cultivation of the soil, was actively resumed. The completion of the main dyke, leading from a point in the high land, not very far from the present Holme Station, 3½ miles long, and averaging 30 feet in width, was an arduous undertaking, owing to the treacherous nature of the bed of the Mere, through which, for nearly two miles of its length, it passed. Frequent slips occurred, and continued to occur long after its first completion. From the main dyke a number of smaller dykes branched off, passed through the silty bed of the Mere, penetrated into the surrounding bog, and tapping it in all directions, brought a never-ending flow of water to be discharged by the engine.

The effect of this network of drains was quickly visible. The bed of the Mere was soon covered with innumerable cracks and fissures, deep and wide, so as to make it a matter of no small difficulty to walk along the surface, while in the surrounding bog the principal effect was the speedy consolidation of its crust, which, by the end of the first summer afforded, even in those places which had been long impassable, as safe and firm a footing for a man, as it now does throughout almost its whole extent for a horse.

It was no easy matter to reduce the Mere-land into a state to receive such seed as should be first sown; the adhesive condition of the surface making it impossible to use horses even when shod with boards, if indeed the wide fissures did not render it dangerous to try the experiment. The whole area therefore had to be prepared by hand—over the largest part light harrows were first drawn by hand—the seed was then sown, and the harrows used a second and sometimes a third time, at a cost of about 5*s.* or 6*s.* per acre. Other parts were dug or forked at an average cost of from 25*s.* to 30*s.* per acre. Of such a depth were the cracks, that even this process, with all the subsequent operations attending the first crop, by no means got rid of these obstinate scars, which continued until the cultivation of three or four years at length obliterated them.

Coleseed and Italian ryegrass were the first crops taken. When the new land was in its raw and wettest state, the latter did somewhat better than the former, but as the soil dried the coleseed throve better, and in the reclaimed reed-shoals and adjoining

skirt-land, good crops of it were grown in even the second and third year, the value of which was on an average 30*s*. and 40*s*. per acre respectively.

The rich alluvial soil, thickly studded with shells, and largely impregnated with animal matter, was, after these preliminary croppings, available at once for the production of wheat and oats, and the wind, which, in the autumn of 1851 was curling the blue water of the lake, in the autumn of 1853 was blowing in the same place over fields of yellow corn. While however the uncovered bed of the Mere, and the reed-shoals, yielded so generously to the hand of improvement, the more arduous task remained of bringing into profitable cultivation the large tract of peat-land surrounding them on the south and south-west sides. On this unproductive tract, as has been said, a heavy tax had been imposed, and it was a matter of deep interest to devise the readiest and most effectual way of bringing it into a remunerative condition.

To subdivide the district into fields, to pare and burn the surface, and to obtain from the broken-up peat-soil some indifferent crops of coleseed and oats, would have helped at any rate to civilize the appearance of the country, and possibly might have shown some margin of receipts over and above the drainage-taxes payable on the land, but undoubtedly it would not have paid as a farming operation, and no tenants would have been found to sink their capital in such an unpromising speculation.

The ordinary method of improving the black peaty soil of the Fens is to give it a coating of the underlying gault, but the practical use of the gault is limited by the depth at which it lies beneath the surface. It is excavated from narrow trenches at regular intervals in the field which is about to receive a coating of it, and the expense of the operation depends entirely on the depth at which it is found; at 4 or 5 feet the men in the trenches can throw it out with ease, and the advantage to the land being great, and the expense not more than from 4*l*. to 5*l*. per acre, it is a highly remunerative process; but at 9 or 10 feet the case is different: and as the benefit to be derived from an ordinary coating of gault does not last more than seven or eight years, there is of course a certain depth beyond which it would be unremunerative to attempt the process of raising it.

In the case of the district we are considering, this point is far exceeded, the average depth at which the gault lies below the surface being about 15 feet. The above-named process is therefore inapplicable here, and consequently another method of fertilizing the peat-tract has been adopted. It consists in covering the bog with soil conveyed by means of a portable railway from certain points in the old bed of the Mere, where it can either be

spared without injury, or where the taking it away is a positive advantage by increasing materially the capacity of the main and other dykes. Indeed in determining the execution of the works connected with the portable railway, the enlargement of the main drain communicating with the engine was almost as important a consideration as fertilizing the bog.

Owing to the very considerable subsidence of the level of the district* the drains had generally lost much of their original depth; and in the main drain, where it passed through some of the lowest land in the old bed of the Mere, the water constantly supplied even in dry weather from the neighbouring bog, and in wet weather from the uplands as well, would, if not kept down by frequent pumping, rise more or less speedily up to and above the level of the adjoining fields. The depth and consequent capacity of the main drain being far too small, the engine, when set to work, in little more than two or three hours, completely exhausts the water; while from the continuous supply in any but very dry weather, it becomes again in a few hours' time full to overflowing, and the engine has to be started again on its Sisiphæan labour.

This constant getting up and letting down of steam is a very uneconomical system, and a remedy, or, at any rate, a mitigation, suggested itself in the idea of greatly increasing the capacity of the main drain towards its lower end, which while furnishing by means of the railway a large supply of the Mere soil and of the gault, which, with a thin stratum of peat between, underlies the silty bed of the Mere, would create for the water descending from the more distant portion of the tract to be drained a kind of reservoir, where it might be stored up till the engine, after enjoying the lengthened intervals of repose thus afforded, should be again summoned to its duties.

The combination of advantages offered by thus improving the main drain and utilising, as described, the rich material excavated from it were so palpable, that in no long time the idea was acted upon.

It was at first proposed to carry the work out on a very considerable scale, with a view to the relief in working the engine to be gained by the enlarged main drain, and this would certainly have been a desirable object, but considerations, partly of a pecuniary nature and partly connected with the difficulty of dealing with a large tract of land suddenly requiring cultivation, deter-

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* The extent of this subsidence has been gauged by means of piles, which at the commencement of the draining were driven in three of the lowest places in the bog into the underlying bed of gault, and were then cut off level with the surface. The tops of the piles when measured this summer were severally 4·9, 5·5, and 6·1 feet above the surface; showing a subsidence of more than 9 inches a year since the draining has been completed. In the same period, as has been said, the bed of the Mere has been lowered 3·6.

mined the adoption of the plan on such a scale as would enable works, such as building, road-making, and the like, to precede, if necessary, the so-called "dry warping" of the bog.

The original scheme embraced 2½ miles of rail, a stationary steam-engine of 25 horse-power, wire-rope proportioned to the length of railway, 200 trucks, &c.; the estimate for the whole plant and for every contingency being all but 5000*l.*

Taking 1500 as the number of acres to be covered with soil 6 inches deep, it was calculated that the cost per acre would amount to 14*l.* 4*s.*; from this would have to be deducted the inconsiderable sum that the plant would sell for at the expiration of the work.

For the smaller operation 1½ mile of iron railway, 1000 yards of portable wooden flanged rails, 50 trucks, and 10 horses, are the principal items of the plant employed, the cost of the whole amounting to about 1500*l.* It is found that with this force, in favourable weather, an acre and a half can be covered to the depth of 4 inches; and a calculation, made in September last, as to what was the actual cost of the work at that time, showed that at 4 inches it was 12*l.* 1*s.* 5*d.*, and at 6 inches deep it was 14*l.* 17*s.* 6*d.** In this calculation, however, the acreage over

* COMPUTED COST of DRY-WARPING, per Acre, on Holme Fen, the property of William Wells, Esq., as obtained from the Audited and Certified Accounts, allowing 200 acres more only to be done with the present Plant, or 270 acres altogether.

	£.	s.	d.	£.	s.	d.
From Statement No. 2:						
Forming roads	3	19	8			
Rails, trucks, &c.	126	7	6			
Trucks	22	0	0			
Iron-works	3	16	7			
Carriage	1	16	3			
Ponies, &c., horse	39	18	6			
Trucks, rails, &c.	142	0	0			
				339	18	6
From Statement No 3:						
Rails, trucks, horses, &c.	105	0	8			
Rails, &c.	73	7	6			
Rails, &c.	35	13	6			
				214	1	8
Estimated to be required:						
¼ mile more portable railway	230	0	0			
2 horses	50	0	0			
Trucks	100	0	0			
				380	0	0
				934	0	2
Deduct estimated value of plant at completion, one-fourth only	..	..		233	10	0
Net cost of plant	..	..		700	10	2

Estimated

which to spread the cost of the plant was only taken at 270; whereas a far larger extent might have been included, and the expense, so far as the cost of the plant is concerned, proportionately reduced.

The average distance to which the soil is conveyed is about $1\frac{3}{4}$ miles. It is hoped that a very small increase of plant, which is about to be made, will, by affording a more economical arrangement of the work, admit of nearly an acre more per week being covered.*

Many questions, bearing upon the success of this undertaking as a remunerative work, can only receive their full answer in the result of experience. For instance: as every additional half-inch of soil increases materially the cost of the work, it is all

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Estimated acreage warped	70
Estimated acreage to be warped	200
	270

	£. s. d.	£. s. d.
Average cost of plant per acre 2*l.* 11*s.* $10\frac{3}{4}$*d.*, say ..	.. ..	2 12 0
Horse keep, &c., for 6 horses, at 12*s.* each	3 12 0	
6 boys	1 16 0	
Horse-keeper	0 8 0	
$1\frac{1}{2}$ acre per week	5 16 0	3 17 4
6-inch warping:		
Excavating and spreading 807 cubic yards, at $2\frac{1}{2}$*d.* per yard		8 8 2
Cost per acre of 6-inch work		14 17 6
4-inch warping:		
Deduct one-third cost of above excavating and spreading ..		2 16 1
Cost per acre of 4-inch work		12 1 5

If an estimate were made now under a comprehensive scheme, designed to embrace the whole Fen, at the reduced rate of cost to which different items have been brought in the course of actual working, its amount would be very moderate indeed as compared with the above statement. As an instance of reduction in prices, it may be stated that the first length of portable railway was purchased at the price of 11*s.* per yard, whereas the last was furnished by Messrs. Verzette and Sons at 5*s.* 6*d.*

* The following items of the plant and labour may be useful:—

Portable flanged wood-railway per yard, from 4*s.* to 5*s.* 8*d.*
Permanent iron-railway per yard, 3*s.* 9*d.*
Trucks, each, from 5*l.* 10*s.* to 6*l.* 10*s.*
Horses, each, about 25*l.*
Labour, excavating, filling, spreading, per cubic yard, from $2\frac{1}{2}$*d.* to 3*d.*
Cubic yards to cover 1 acre 6 inches deep = 807.
Ditto ditto 4 inches deep = 538.

important to ascertain the exact measure to be applied with a view to a permanent improvement.*

In the ordinary gaulting in the Fens—costing, as has been said, from 4*l.* to 5*l.*, according to the depth of the pits—a top-dressing of not more than 1½ inch, or, at most, 2½ inches, is laid on. This becomes, in the various stages of cultivation, first incorporated with, and finally lost, as it were, in the peat soil; so that at the end of seven or eight years the process has to be repeated.

In the case of the operations by rail, it was obviously essential that the work should be a permanent one—done for once and all, and it was decided to try a covering of 6 inches of soil for arable, and 4 inches for pasture-land. At 6 inches deep there may seem some danger of the soil, under an ordinary system of cultivation, being, as in the case of the thin coatings of gault, mixed up with and finally lost in the bog beneath; but it has been thought that, rather than go to the expense of a deeper covering, it was worth while to encounter this remote risk. Care must be urged upon all who may occupy the warped land not to disturb by too deep a cultivation the peaty subsoil beneath. Scarifiers, grubbers, and many implements other than the plough, may beneficially be employed; and even if the plough be employed, and uniformly at the shallow depth which a coating of 6 inches of soil allows, there would, at any rate, be none of the disadvantages of a hard and impervious pan. It is hoped that 4 inches of the alluvial deposit from the bed of the Mere, or of the underlying gault, will be sufficient to secure a good permanent pasture. As, however, supposing the rate at which the works are now proceeding to be maintained, it will be some years before the whole district is reclaimed, there will be an opportunity of noting whether a correct judgment in these matters was originally arrived at, and modifications may very possibly have to be made, as well with respect to the thickness of the coating of soil as to other details.

One very important process in the reclamation of the peat-bog must not be forgotten, without which, indeed, experience has shown that half the value of the warping would be lost. The stagnant water must be drawn off, as far as possible, from the

* Since the above was written, an analysis made by Professor Voelcker of the blue gault or clay-marl underlying the alluvial bed of the Mere has been made, and gives such highly satisfactory results, that it seems doubtful whether it may not be expedient, for the sake of covering the area of the bog more rapidly, and thereby obtaining a more speedy remuneration, to diminish considerably the depth of the coating, even at the sacrifice of the permanence of the operation. A coating of 4 inches for arable, and of 3 for grass land, will now probably be adopted; and a great authority recommends even a slighter and consequently more rapid covering of the surface than this, as a matter not only of present but ultimate economy.—W. WELLS.

peat before the soil is laid on it. To this end, drains must be cut at intervals of 2 chains, at as great a depth as the water in the ditches which surround each division, or rather each future field, will permit,—being, on an average, about $3\frac{1}{2}$ feet. The drains are easily formed, in a manner well known in many districts, by leaving, at the depth of one draw of the spade from the bottom, a shoulder or ledge, upon which the excavated turf is laid, thus covering and leaving below it a channel for the water of the bog to percolate into and discharge by. Nothing can be more satisfactory than the effect that this rude subsoil-draining produces upon the character of the bog, without which precaution any attempt to warp upon the bog saturated with peat-water would be attended with comparatively little success.

It may not be out of place here to suggest that there may be many large districts circumstanced more or less like the one we have been describing, where a similar method of fertilization, perhaps on a larger, and if so, on a proportionately less costly scale, might be adopted. Some of the richest soil in Ireland is in immediate juxtaposition with large tracts of bog, and although without examining the case of such districts carefully—taking into account the value of the peat for fuel and weighing many other circumstances—it would be impossible to form an opinion as to the practicability of applying such a scheme to them, yet there does certainly seem to be a sufficient similarity between the two cases to justify the suggestion that an "Irish-Bog-Reclamation Company" be forthwith formed.

It must be here remarked, that, in the more recent operations, the assistance of a company of a less speculative character than the one suggested above has been called in;—one, in short, of those associations, which, as companies sanctioned by Parliament, afford, on no unreasonable terms, facilities both pecuniary and engineering, without which, in many instances, improvements, even the most obvious and desirable, could not be carried out. It has been with the able assistance and under the careful supervision of Mr. Thompson, the engineer to the "West of England Drainage and Inclosure Company," that the warping, turf-draining, and a large extent of road-making have been carried on; and although of course the profit to the company increases to a certain extent the cost of the work, yet a large set-off may be reckoned in the advantage derived from their organised system of supervision, account-keeping, and, above all, their power of supplying experienced and trustworthy foremen. The terms on which the company are carrying out the work may be calculated as an addition of between one-eighth and one-ninth of the cost; but in justice to them it must be remembered that if the work had been carried out on the larger scale, which they were much

in favour of, the proportion of their charges to the entire cost would have been less.

Having briefly traced the fortunes of Whittlesea Mere, from the time when the possibility of draining it seems first to have assumed the shape of any definite scheme up to the present time, when a complete realization of the most sanguine views entertained on the subject has been effected, it may be interesting, before ending this paper, to observe what has been the result of the change as regards the productive power of the reclaimed district. Although 5000 acres feel the influence exercised by the Appold pump, yet inasmuch as about 2000 acres were in a state of cultivation long before, and now only benefit incidentally by being taken into a well-regulated and efficient system of drainage, it will be proper, for the purpose of the comparison proposed, to confine ourselves to the 3000 acres, covered heretofore with water, reed-shoals, or sedge.

Although the fish from the Mere, the reed from the shoals, and the sedge from the bog, were doubtless, in their day, of some value, and employed, more especially in the case of the reeds, no inconsiderable amount of labour in their collection, it would be difficult now to give an accurate estimate of their worth; and probably the mention of these as the sole products of the Mere and its environs will enable the reader to appreciate sufficiently the contrasted produce of the district.

Of the 3000 acres about one-half consists of the bed of the Mere and old reed-shoals. These have now for some years yielded abundant crops, under a regular system of cultivation. Of the remaining 1500 acres of peat-soil, a small portion has been already covered with soil from the Mere, and the remainder has, by breast-ploughing and levelling, been brought into a state partially productive, for it will, as mentioned already, yield indifferent crops of coleseed and oats, and at any rate is now in a condition to receive the warp as fast as it can be laid on. The estimation of the produce of the first 1500 acres is comparatively easy and to be depended on, but that of the remaining 1500 must be somewhat vague, for the true value of the warped land is not yet established, and a much larger proportion will be in grass.

The following calculations will however be considered, it is hoped, to give a fair approximate representation of what the produce of the district is worth, both in money-value and in the food it will yield for man and beast:—

		£.
600 acres of wheat at 4 qrs. per acre = 2400 qrs. at 40*s*.		4,800
500 acres of oats at 6 qrs. per acre = 3000 qrs. at 20*s*.		3,000
150 acres of seeds 150 acres of coleseed 100 acres of mangold	150 beasts at 3*l*. increase of value in a year	450
	400 sheep at 1*l*. ditto	400
		8,650

200 acres of wheat at 3½ qrs. per acre = 700 qrs. at 40*s*.		1,400
200 acres of oats at 5 qrs. per acre = 1000 at 20*s*.		1,000
1000 acres of grass }	100 beasts at 3*l*. increase of value in a year	300
100 acres of green crops }	1000 sheep at 1*l*. ditto	1,000
		3,700
		8,650
Total value of the produce of 3000 acres		12,350

The amount of food for man and horses may be calculated as follows:—

* Wheat, 3100 qrs. = 1 lb. flour at 1 lb. per day per year for 3329 persons.
Oats, 4000 qrs. = 2 bush. per week per year for 307 horses.
Bran, 155 tons.
* Beasts, 250 tons at 20 stone = ½ lb. per day per year for 382 persons.
* Sheep, 1400 tons at 5 stone = ½ lb. per day per year for 306 persons.

This comparison between the producing power of the district in its former and in its present state shows results which may well encourage enterprises of a similar character. It is true that the balance-sheet between the let-able value of the land and the cost of the operations is disagreeably affected by the tax imposed under the Middle-Level Act, for works, without the execution of which the Mere and its neighbourhood could equally have been drained. This tax averages 12*s*. 3*d*. an acre,† and its non-imposition would have left a corresponding amount on the profit side of the Whittlesea Mere works proper.

But the accomplishment of a success, on however small a scale, must be reckoned as a profit; and the satisfaction of contemplating the changed aspect of the district, as well as the improved condition of the neighbouring poor, both in respect of constant well-paid employment and better health, is alone a never-failing and substantial interest for the capital expended.

Red Leaf, Penshurst.

Composition of Clay, No. 1. underlying the Upper Stratum of Peat, taken from the bed of Whittlesea Mere (sent by Mr. Wells).

	Dried at 212° F.
Organic matter and water of combination ..	6·23
Oxides of iron and alumina	9·61
Phosphoric acid	·42
Sulphate of lime	1·04
Carbonate of lime	13·58
Magnesia	1·51
Potash and soda	1·53
Insoluble siliceous matter	66·08
	100·00

* Taking wheat at 63 lbs. per bush. = 36 stone per quarter = 392 lbs. flour; a beast to weigh 60 stone of 8 lbs. at 3 yrs. old, and to produce 20 lbs. in a year; and a sheep to weigh 10 stone of 14 lbs. at 2 yrs. old, and to produce 5 stone in a year.

† 13*s*. 9*d*. per acre on 1000 acres }
8*s*. 9*d*. per acre on 500 acres } Mere average 12*s*. 3*d*. 6*s*. per acre on bog land.

Composition of Clay, No. 2, underlying the Second Stratum of Brown Peat in the bed of Whittlesea Mere (sent by Mr. Wells).

Moisture	2·52
Organic matter and water of combination ..	4·70
Oxides of iron and alumina	10·68
Phosphoric acid	·16
Sulphate of lime	·25
Carbonate of lime	11·74
Carbonate of magnesia	2·12
Potash and soda	1·32
Insoluble siliceous matter	66·51

Composition of White Light Substance (peaty marl), the Upper Stratum of the bed of Whittlesea Mere (sent by Mr. Wells).

Moisture	9·31
Organic matter (peat)	17·34
Oxides of iron and alumina	1·01
Phosphoric acid	·03
Carbonate of lime	64·77
Magnesia	·30
Sulphate of lime	1·87
Insoluble siliceous matter (sand)	5·37
	100·00

Augustus Voelcker.

Royal Agricultural College, Cirencester,
June 22, 1860.

The following memoranda may be not unworthy of record as the results of an interesting day spent in examining the Mere, in company with Mr. Wells, Mr. Laurance, his agent, and Mr. Cole, late steward to Captain Wells on a Mere farm.

Of the information given to me all that relates to general management or scientific research was derived from Mr. Wells or his agent. Mr. Cole, on the other hand, was well qualified to speak, not only to farming details, but also of the nature and value of the old products of the Mere and its surrounding fen, which had been hired by his father and himself up to the time at which the work of reclamation commenced.

It appeared that the fishery had been reckoned to be worth about 30*l.* a-year; the 200 acres of reed-bed which fringed the Mere produced annually 1000 bundles of reed, worth 5*l.* per acre; the sedge which grew outside the reed-bed was cut once in 3 years, and produced about 1000 bundles, worth 1*l.* per acre; the 1200 or 1300 acres of fen held with the Mere had an average value of about 2*s.* per acre for the joint purposes of sedge-cutting and rough pasturage.

With these products may be contrasted the following estimate

of crops now grown on the bed of the Mere, or on the site of the adjacent reed-bed :—

Wheat	5 to 6 qrs. per acre.
Oats	7 to 8 ,,
Beans	about 3 ,,
Barley not grown.	
Mangold	40 tons.
Clover	1 ton 10 cwt. to 2 tons.
Potatoes	7 to 8 tons.
Carrots	8 to 10 ,,

On the site of the Mere about two-thirds of each farm was under corn; the bulk of straw grown was enormous, as testified by the size and number of the stacks; the supply of straw for manure was in excess of the requirements of the land, except where some of the poorer fen had been attached to the holding,—an arrangement which may be further carried out to the benefit of the estate as the work of improvement proceeds.

The eye easily traced out the limits of this area by the altered appearance of the crops growing in the fields beyond. A late spring-frost had occurred a week before the date of our visit; the amount of injury it had done was graduated very nearly in inverse proportion to the quantity of silt or clay mixed with the peat in the several fields.

On the site of the Mere no harm had ensued; the wheat was vigorous and even rank in its growth; on the inferior lands surrounding it the corn had a rusty appearance; whilst the fields of the worst quality appeared to be losing half their plant of wheat, with a prospect of the crop being reduced to 3 or 4 sacks per acre. This land, which skirted the Mere, derived its powers of producing corn from the silt which was deposited on its surface by floods; and, consequently, its value depended on the amount of that deposit. Its produce has always been variable from the injurious influences exercised on it both by drought and frost.

Some farmers conceive that the work of drainage has been of very questionable benefit to land of this description, because it is now laid more dry than it used to be. However this may be, there is more satisfaction in looking forward to the time when an ample dressing of clay may obviate the mischief which arises from late frosts, as well as that caused by drought, than in looking back with regret to a state of things which, at the best, produced but inferior and uncertain results, under which the excess of moisture, which was a palliative against the effects of heat, served only to augment the evil arising from frost. The clay for one dressing might be provided, for a large tract, from the bed of the Mere, and laid on by a railway; whilst there are grounds for hoping that, before the good effects of this application had been worn out, the peat subsoil will have become sufficiently

compressed to admit of a second dressing of clay being raised directly from beneath.*

It is to a tract of fen situated beyond the reach of the former floods, and, therefore, more remote from the Mere than the lands last mentioned, that the clay is now being applied by railway. Antecedent to this work, some attempts at cultivation seem to have been made; but the task must have been most unsatisfactory to a man of enterprise, when he saw his utmost efforts repeatedly met by the very inadequate return which the unclayed peat would make even in a favourable season. Such efforts, however, have not been thrown away, as, under any circumstances, a good deal must be done to the rough surface of the fen, full of inequalities to the extent of from 1 to 2 feet, and covered with a felt of sedgy grasses and roots, before the surface is level enough to receive the clay, or the mass of roots is broken up into anything which deserves the name of soil for admixture with it.

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* The following grounds may be assigned for the belief that the clay will ultimately be raised directly from below the fen.

Around the Mere, when the water was drawn off, there was a bed of peat as much as 22 feet in thickness above the blue clay. As Mr. Wells has shown, this surface has subsided at the rate of about 9 inches in a year, or 6 feet in all since that date; or in other words, this bed of peat has been already compressed to that extent. The surface over the bed of the Mere has in the same period sunk 3 feet 6 inches. This subsidence does not admit of so easy an explanation, for on the site of the Mere there are now only about 5 feet of soil above the blue clay, of which the 3 upper feet consist of silt combined with some peat (as shown in Analysis No. 3), and the 2 lower feet of compressed peat.

It may seem a startling assertion that this subsidence on the Mere bed must be attributed chiefly to the underlying peat having been compressed from a thickness of over 5 feet to that of 2 feet; but any other explanation of the phenomena would probably be attended with even greater difficulties than this. At the period when the formation of the peat began (probably in consequence of some sudden elevation of the district), the surface of the area over which it extended must, from the nature of the case, have been nearly level,—just below or just above the range of the water-level. When water began to stand in pools, the nucleus of the Mere would be formed in a depressed rather than an elevated portion of this area.

It can then hardly be supposed that the clay surface under the Mere is, or ever was, higher than in the surrounding fen. And yet at this spot it is now within 5 feet of the surface, although elsewhere it is sunk below 16 feet of peat. It would be interesting to know how much the top of the 22 feet post driven through the peat (which now stands 6 feet out of ground) is above the present level of the Mere bed. But apart from this and other such inquiries, we may state our case briefly as follows:—

If the surface of the blue clay be level and incompressible:

If the silt would not shrink greatly when dried (say more than 6 inches in the $3\frac{1}{2}$ feet):

. Of the subsidence of the Mere bed (amounting in all to 3 feet 6 inches), 3 feet must be due to the reduction of the peat from a thickness of 5 feet to 2 feet; and thus we should obtain a maximum estimate of the amount of compressibility of peat in 9 years, when it has previously been thoroughly saturated with water, and subsequently exposed to the full influence of a powerful draining apparatus. The thickness of 22 feet of peat seems to be a maximum thickness over a considerable area: at the rate above indicated, these 22 feet would be reduced to 9 feet in nine years as the maximum depth of the clay if the soil were thoroughly exposed to drying influences as the Mere bed has been; whilst on other spots the clay would be proportionately nearer to the surface.

The order and cost of this preliminary work is nearly as follows:—First, the surface is pared, burnt, and partially levelled, at a cost, per acre, of 1*l*. 5*s*. Next, the ashes are spread, and the field breast-ploughed, at the rate of 1*l*. Cole-seed is then sown, which gives a small amount of feed, worth perhaps 6*s*. per acre in the autumn; but it springs up solely between the interstices of the long slices cut by the breast-plough, the sod itself remaining tough and unbroken till the next spring, when, as the land is still unable to bear horses, the long strips are chopped by hand, at the cost, per acre, of 10*s*. The land is then again dug and levelled for 1*l*. 5*s*. Shallow drains are cut and laid with turf, 44 yards apart, at a cost, per acre, of 5*s*.; and the land is then considered ready for the warp of clay.

Oats are sown upon the warp as far as the progress of the work of the season will admit, and with the oats a layer of timothy grass and clovers. The oats give a fair return; and the pasturage of the grass, which stands for 3 or 4 years, is worth about 30*s*. per acre. The course, which, after this, can be adopted to the best advantage, yet remains to be determined. Continued pasturage, or a succession of wheat, oats, potatoes, and mangold, have their respective advocates.

The fields, now under layer, on which the warp had been spread, and oats grown in 1859, showed streaks in which the plant was weak, if not defective. A little consideration pointed out the probable cause of the variation. Of the soil excavated from the bed of the future reservoir to a depth of 12 feet, the upper 3 feet consists of silt and silty peat, the 2 next of peat, and only the lowest 7 feet of blue clay. The whole mass was alike put into the trucks, and spread evenly, so that the land which chanced to receive a dressing of silty-peat lost by the lesser specific gravity as well as by the inferior quality of that material.

Our time did not permit us to examine, as they deserved, either the complete modern homesteads erected on the site of the Mere, or the excellent roads formed to connect them with the high land, for which, as no materials are to be found on the spot naturally adapted for road-making, a large supply of ballast is provided by burning the clay with peat.

The evening was devoted to the investigation of the strata next below the bottom of the reservoir now in course of excavation.

It has been stated above that the 3 upper feet of the bed of the Mere consisted of silt, the next 2 feet of common black peat, below which the blue clay has been excavated to a depth of 7 feet, to the bottom of the new reservoir. Some stout workmen dug down, in our presence, to a further depth of 6 feet 6 inches, which brought them to the bottom of this stratum, of which a specimen is examined in Analysis No. 1.

This whole bed of clay is very moist; so much so that when dried it loses one quarter of its weight. At about 3 feet from the bottom it began to present a blackish appearance, and to contain numerous but minute cockle-shells.

Immediately below the clay we came upon a bed of *brown* peat, to the depth of 2 feet 4 inches. Within these limits lay, as in a cake, parts of the roots, trunks, branches, and leaves of the original forest, which was overthrown when this plain was probably converted into an estuary; the Scotch fir, the birch, and the hazel seem to have been the prevailing trees. The workmen immediately observed a sulphurous smell connected with the fragments which they brought up, a fact which may perhaps account for the blackening of the clay above. Under this brown peat lay the clay, of which a specimen is examined in Analysis No. 2. This latter clay resembled that above in colour, but differed from it remarkably by being much more solid and dry, as if the peat above had tanned itself into a mass impermeable to water. It is the same clay stratum which may be seen in the trenches alongside the Great Northern Railroad, near Holme Station, with the stumps of the forest standing erect in the bottom of the trench.

With this investigation we closed our survey of this great undertaking, which is not the only service that Mr. Wells has rendered to agriculture, as the list of prizes and commendations awarded to stock exhibited at Canterbury testifies more than once.—P. H. F.

IX.—*The Proper Office of Straw on a Farm.* By HENRY EVERSHED.

PRIZE ESSAY.

STRAW is used on most farms, both as food for stock, and as a bed for them to lie on; I shall therefore endeavour to assign to each of these uses its proper value. The requirements of the farm-yard necessitate, as I believe, certain modifications in the use of straw; and the system of letting the cattle "eat their liking" from the crib, and tread the rest under foot, though still finding favour in some secluded districts, may be amended.

The present high price and growing demand for meat will make us all look inquiringly at our straw-stacks, anxious to know whether all their value departed with the grain, or whether there be not beef and mutton latent in straw as well as in turnips.

It is a common remark on many of the best managed and most profitable farms, "How shall I manage to tread all this straw into good dung?" And on other farms differently situated, "How shall I get straw for all this stock?"

It is, however, a mistake in any case to be too anxious to "tread in" straw. Straw is not dung; it is, as litter, a medium for soaking up the liquids and solids of the farm-yard, making a dry bed for cattle. Taking its market value at 1*l.* per ton (in some neighbourhoods it is twice as much), fifty tons will buy 50*l.* worth of guano, worth on any farm more than fifty tons of straw merely "trod into dung." *

The using of straw for the sake of getting rid of it, is a miscalculation, and any covenants which necessitate this by withholding permission to sell it, are surely founded in error.

I shall now turn to a more common state of things, where straw is not in excess of the ordinary requirements of the farm: first examining what appears to be the most important, because the most indispensable, of the uses of straw, viz., as litter. All the larger animals require litter of some sort. A warm, dry, and soft bed is quite indispensable for their comfort. As an expedient for saving straw, I once put twelve three-year-old oxen on boards to fatten, and found it a very cruel experiment. The animals were always in a state of distress; one of them refused to lie down, and remained standing four days, until the muscles of the thigh swelled from the unnatural tension. A comfortable layer of straw soon set all right again, and as the spaces between the boards allowed the moisture to pass into a drain, a great saving of litter was effected.†

A wish to save straw occasionally leads to a sparing use of it in the yards, always resulting, however, in the immediate discomfort of every head of stock. In fact, the best of food, and unremitting attention, will not compensate for the want of a comfortable bed. Frequent supplies of dry litter in sheds and yards are absolutely necessary. Those who are accustomed to a well

* The above conclusions are not strictly correct, or at least not applicable in all cases. 1st, although straw be not dung, yet the carbon as well as the minerals which it contains have a positive value as manure, and exert a special influence on light sandy soils. On such soils guano is a very inadequate substitute for farmyard-manure. Moreover, in the case before us, 50 tons of straw must be taken to represent a large number of tons of inferior manure. On farms where a good head of stock is economically fed, it must be quite an exceptional case if there be any superfluity of straw; because, where the land is strong and the climate moist, so that a great bulk of straw per acre will be grown, there will generally be a considerable admixture of pasture with the arable land: when the land is light and the climate dry, and the farm almost exclusively arable, the yield of straw will not be great, and a considerable portion of it will be required as a substitute for hay in feeding the stock. A good farmer does not generally find that he has more straw than he can turn to *good* account, although, under certain circumstances, he may think it *better* economy to sell a portion, and replace it by purchased manure.—P. H. F.

† The cocoa-nut matting used by Mr. Horsfall in his cow-stalls may be found serviceable by other farmers who, as in his case, are situated in neighbourhoods where straw is both dear and scarce. It would not, however, be used to the same advantage for steers as for cows.—P. H. F.

stocked farm-yard are aware how entirely success depends on attention to details; the omission of any of these mars all. A comfortable bed is one of the most important.

It may be asked, "Is it the proper use of straw, to be spread over the wet surface of a yard, to be soaked by rain, and then covered up by a fresh layer, and finally 'trodden' into indifferent dung?"

This question brings me to the subject of covered yards. The desire to spare straw led to the erection on my own farm, and on another under my direction, of sheds covering a considerable space of yard, besides cattle-boxes. It would be quitting the present subject to expatiate on the various advantages derived from these arrangements; I may observe, however, that one great advantage is the saving in straw which they effect.

With regard to live stock, I have seen them thrive as well in warm, sheltered yards, open to the sun, and well supplied with litter, as in the best-appointed stalls, boxes, or covered yards. But the litter is wastefully used, the manure less valuable, and the amount of cartage greater.

The quantity of rain falling in a year, on a yard 50 ft. by 40 ft., at 25 inches per annum, amounts to 25,967 gallons, weighing nearly 116 tons. During heavy rain a large quantity runs off, carrying with it the soluble portions of the manure; but after making due allowance for evaporation, there will remain many tons absorbed by the straw, costing nearly 7*d.* per ton if carted a quarter of a mile.* In covered yards the dung is concentrated; it is never washed; and cartage—that costly item—is reduced to a minimum.

The quantity of straw required to keep open yards in a comfortable state, depends of course on the weather; and also on the kind of food given to the stock. Turnips and green food increase the secretion of urine, and litter is needed in proportion.

In ordinary years, and in open yards, with sheds, 50 head of stock require, as litter, 300 tons of straw in nine months, from Sept. 1st to June 1st. This reckoning supposes ten horses to be kept in the stable, whose litter is thrown daily into the yards; the rest being cows and fattening cattle. The amount of straw

* This cost of 7*d.* per ton is thus estimated:—

	s.	*d.*
2 men to fill 36 tons	3	8
5 horses and 4 carts (a trace-horse being employed to drag the load on to the heap) at 2*s.* 6*d.*	12	6
2 lads to drive	1	8
1 man at the heap	2	2
	20	0

$$\frac{\overset{s.}{20}}{36} = \frac{\overset{d.}{20 \times 12}}{3 \times 12} = \frac{\overset{d.}{20}}{3} = 7d. \text{ nearly.}$$

—H. E.

used daily per head is 48 lbs., or twice as much as is required under shelter.

It is stated in an excellent paper on manure, in 'Morton's Cyclopedia,' that 20 lbs. of straw per day are required to litter an ox, in a box containing 100 square feet. This agrees with the quantity used in my own boxes, in each of which I find, after six months' fatting, 8 tons of dung, 6 tons 8 cwts. of which are derived from the ox, and 1 ton 12 cwt. from the litter.* About 24 lbs. per head are used in the covered yards, which are occasionally treated to a dose from the stable-tank.

Fifty head of beast, fattened in covered yards, will produce in six months—

	Tons.
Voided by the animals	325
Litter (24 lbs. per head daily)	100 nearly
	425

425 tons of dung, fit to plough into the ground at once.

The same stock in open yards will produce—

Voided by the animals	325
Litter (48 lbs. daily)	200
Water	?
	525

525 tons of mixture, to be carted to a heap and fermented. This is exclusive of a great weight of water.†

In six months fatting of 50 head of cattle, in covered yards, the amount of straw saved is therefore 100 tons; worth, at Mr. Horsfall's estimate, 35s. per ton, to convert into butter and beef!

I conclude this part of the subject by observing, that the proper use of straw as litter is, to provide a comfortable bed, and to absorb the excrements of the stock. These conditions can only be fully secured when the bed on which the animals lie is covered.

Straw as an article of Food.

All cattle will eat a certain quantity of straw if they can get it. The calf, who knows no stint, nevertheless, chews straw in his pen, and the pampered medallist at Baker Street, or Bingley

* Mr. Lawes informs me that he takes from his horse-boxes, of the same size, 6 tons in 6 months. The one statement corroborates the other, or rather Mr. Lawes shows quite as small a decrease as I should have anticipated from the horse being out at work during so many hours. As far as I could ascertain, the supply of straw given to the horse averaged quite as much as 20 lbs. per day; and if this be the case, the horse would contribute about two-thirds as much as the ox to make up 6 tons.—P. H. F.

† The exact weight of water left in the dung cannot easily be estimated, as a portion evaporates and some runs off; but if 116 tons per annum fall on a yard 50 feet by 40 feet, and if eight such yards are needed for 50 head of stock, and if the dung be exposed during 6 months of average rain-fall, the 525 tons of dung will be soaked by 464 tons of water.—H. E.

Hall, astonishes wondering citizens by condescending to eat a portion of his bed.

Nor is this an abnormal condition of things. Any one who will visit those beautiful southern counties, celebrated by Cobbett in his "Rural Rides," where picturesque little homesteads are dotted about the country, and the sound of the flail may yet be heard, will find the fatting cattle standing by turns at the barn door, disposing of each choice handful as it is put forth, and when duly satisfied retiring to the shed to chew the cud, showing every sign of content and enjoyment.*

The yards of the smaller farmers, as yet untouched by modern innovation, often display an interesting picture of neatness and economical contrivance. That look of comfort pervades them, which is of the first consequence to the well-being of stock, and without which "Tables of Nutrition" will be studied in vain.

The analyses appended to this paper show that straw of various kinds contains rather more of the muscle and flesh producing substances, and considerably more of those which furnish heat and fat, than turnips. A ton of straw contains more food than a ton of roots. But if cattle are fed on the latter alone they will thrive,† and on the former store stock will barely, under any circumstances, retain their condition. This proves nothing as to comparative value, but it proves that the elements of nutrition must not only exist, but they must exist in an available form.

An ox fed on oil-cake alone would shortly die, because the elements of nutrition would not be presented to him in an available form. But it does not follow that oil-cake presented in some other form could not be digested. The same applies to straw; and, indeed, we should be led to conclude, from the fact of an ox requiring so much bulk in his food, that straw might be employed to supply that need.

Straw is a cheap article with which to distend the stomach, and we ought to use it in just such proportions as we find, by experience, it can be profitably used, as a substitute for other and more expensive food. There are two main elements in our

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* This picture belongs to the poetry of agriculture. No doubt the best-fed beast delights in an occasional lock of straw, which doubtless is of great service, directly to digestion, and indirectly to nutrition; but he likes it as the citizen does his plain-boiled potato *with his steak*, or the northern tourist his thin oatmeal cake, or single saucerfull of porridge *with cream*. But our author shows plainly, further on, that he does not overrate straw as the mainstay of a dietary, nor does he seem to consider the natural form of straw to be the most available form for the *general* purposes of nutrition. The hint on "comfort" which follows is a word in season.—P. H. F.

† Surely not alone? When was this ever put to the proof? Farmers, talking in a loose way, may have boasted of fatting beasts on turnips alone, but this was most probably effected in well-littered yards; so that they spoke *taking no account* of the straw consumed in addition, the value of which, as an auxiliary, is sufficiently indicated in the previous page.—P. H. F.

calculation: cost of food, and value of beef produced. There is another: value of the manure. But although nitrogenous and other elements are worth something as manure, they are worth more in the shape of meat. Cattle should be fed, therefore, so that as little as possible goes into the manure. In other words, the food should be given in such a form that the animal can appropriate the maximum of its most valuable constituents.

There are few farmers who do not use straw to some extent as a substitute for some portion of the more costly articles of diet. Perhaps its most general use, in this way, is as food for store cattle in combination with roots. If 20 lbs. of straw and 1 cwt. of roots cause an ox to thrive as fast as 2 cwt. of roots, then there will be a gain to the feeder by using the former.

		s.	*d.*
Cost of 2 cwt. roots at 7*s.* 6*d.* per ton .. .. =		0	9
Cost of 1 cwt. of roots .. .. =	$4\frac{1}{2}d.$	0	$6\frac{5}{8}$
And 20 lbs. of straw at 1*l.* per ton = nearly	$2\frac{1}{8}d.$		
Gain		0	$2\frac{3}{8}$

This is a saving of $26\frac{1}{2}$ per cent. nearly.

It is a common plan in grazing districts, where roots are scarce, to feed store cattle on about 20 lbs. of straw and 3 lbs. of bean meal. I have found them do better on straw, with roots instead of meal, even when the supply of roots did not exceed $\frac{1}{2}$ cwt. per head per day. Cattle wintered on straw and meal only become "hide bound" with staring coats.

The cheapest, though not probably the most economical, plan of feeding store cattle is to give them whole roots, and to put the straw, uncut, into racks, making them, in fact, cut and prepare their own food. The objection to this plan is the danger of choking an animal by a small root, or a portion of one, sticking in the throat. There is great risk of such an accident when the roots are small and hard. Mangold, being soft and usually larger than turnips and Swedes, may be given with comparative safety. Store animals fed in this way will do well, and perhaps as well as on prepared food, probably in consequence of the more perfect mastication and deglutition of food when taken slowly.

It was one of the advantages of thrashing by flail that the straw came daily from the barn into the racks as it was wanted. Under the present system it will generally be found more convenient to cut a portion of the straw stack into chaff at a leisure time, and store it away for future use. It is quite indispensable to store it in a place free from damp, for unless kept perfectly sweet it will disorder the stock, and will not be eaten with relish.

A cheap and excellent floor for a chaff house is made with asphalte; and unless the site is particularly dry, the interior

walls should have a coating of the same material, reaching three or four feet from the ground.

The cost of cutting straw into chaff with a machine driven by horse gear is 6*s.* per ton. And it costs quite as much to cut it by steam power, unless other machinery, covering part of the expense, is driven at the same time. Under the most favourable circumstances a saving of 2*s.* per ton may be effected.*

It has been suggested that steaming straw renders it more wholesome. On trial I find that a large apparatus with two "pans" will steam 250 bushels, weighing 1625 lbs., in a day, at a cost of 7*s.* 6*d.* per ton. This quantity would be sufficient for 90 head of cattle, supposing each to receive 18 lbs. daily. The expense of steaming a smaller quantity is much greater in proportion, as the cost of fuel and attendance cannot be reduced in proportion to the smaller quantity of straw steamed.

The expense of this process is very much reduced, when the waste steam of a fixed engine can be employed.

If it cost 6*s.* per ton to cut straw into chaff, and an additional 7*s.* 6*d.* per ton to steam it, then it may well be doubted whether the cost of preparation is warranted by the value of the article when prepared.

Straw with its 40 per cent of woody fibre is, at the best, anything but digestible. And we know of no available method for converting this fibre into food. Steaming does not appear to do much for it except to make it palatable; and I believe, the advantages derived from steaming may be obtained at much less cost, by fermentation with pulped roots.

Fatting cattle can readily be induced to eat from 10 lbs. to 14 lbs. of straw-chaff by mixing it with their cake or corn. Either fatting or store cattle will eat any kind of chaff when mixed and fermented with pulped roots. My cows are at the pre-

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* Details of cost of chaff-cutting:—

	£	*s.*	*d.*
1 man to feed	0	2	0
1 man to supply him	0	1	8
2 men to straighten the hay or straw	0	3	4
1 man to remove chaff to chaff-house	0	1	8
1 man to drive horses	0	2	0
2 to bring hay or straw from the stack to machine	0	3	4
1 horse for ditto	0	2	0
3 horses to work by turns, two at a time ..	0	6	0
For use of chaff-cutter and horse-gear (10 per cent. on 25*l.* if used once a-week)	0	1	0
	£1	3	0

If 4 tons are cut in a day the cost is 5*s.* 9*d.* per ton: it would, however, be a long day's work to cut that quantity into short chaff fit for feeding cattle with a 2-horse gear. If allowance be made for short days in winter, when chaff is most in use, and for the interruptions which sometimes occur, 6*s.* per ton is not too high an estimate.—H. E.

sent time eating 18 lbs. each daily of straw chaff prepared by this method; and I have found no difficulty in inducing them to eat rape-cake, which otherwise they would not touch, by grinding it small and mixing it into the heap of pulped roots and chaff.

With regard to the value of different sorts of straw, any kind saved in good condition is better than any other kind at all damaged. If at all injured, it should be condemned for litter; none but the best should be given to stock. The nearer it approaches to ripeness when cut, the less wholesome and nutritious it is.

Cattle prefer oat-straw, or barley-straw with clover in it, and both are excellent fodder. Pea haulm is eagerly eaten by sheep, and is very serviceable in the racks of horses and store-cattle in the winter months. On sheep-farms every handful should be saved for the ewes and store flock.

Bean haulm is frequently exposed too long in the field, but if carted in good condition, it should be carefully saved and cut into chaff. For although cattle and horses will eat it from racks during the winter months, they will waste a portion. On dairy-farms bean-straw is especially useful for the cows, and may be made palatable by fermenting with pulped roots.

It is an interesting fact that well-fed cattle, kept in open yards, will eat more straw during the winter months than other cattle kept under the warm shelter of a roof. The careful manager saves his stock of bean-straw until the cold weather sets in, knowing that at that season its bitter flavour will be disregarded.

During the present winter I compared the quantity of mixed hay and straw-chaff eaten by six oxen, fattened in a warm cattle-house, with that consumed by cattle of the same age and breed in an adjoining yard. Each lot was fed alike in respect of corn and roots, and as much chaff was given as they would eat. Those in the house ate 14 lbs., and the others 18 lbs. daily; showing a difference of nearly a fourth less carbonaceous food, required by cattle when kept in a condition of artificial warmth.

This fact indicates the value of straw for maintaining animal warmth. It would require a long course of experiments to ascertain its value as compared with hay and other articles of food. The results of experiments of this kind are frequently unlike. They are affected by the age and breed of the animal, by the kind of food used in connexion with the straw, by temperature and other circumstances. When animals are much exposed to cold it may be right to give them a considerable quantity of straw, and but little hay, in their food; but it does not follow that it would be right to give the same quantity and proportions, on removing the cattle to a warm house. We have

already seen that when kept warm they require less carbonaceous food.

Straw is not sufficiently digestible and nutritious to be a desirable addition to the food of young animals.

Having thus pointed out the known value of straw as an article of food, I now leave it to the reader to decide whether in his own particular case he cannot profitably convert more of it into meat.

Composition of Wheat-straw, air-dried. From MORTON'S 'Cyclopædia.'

Nitrogenized, or muscle-producing substances	1·85
Substances free from nitrogen, heat and fat producing substances	26·34
Insoluble substances	41·22
Mineral substances	4·59
Water	26·00
	100·00

Barley-straw. From MORTON'S 'Cyclopædia.'

Nitrogenized substances	1·70
Free from nitrogen, soluble and insoluble	82·12
Mineral	5·24
Water	10·94
	100·00

Oat-straw. By BOUSSINGAULT.

Nitrogenized	1·8
Non-nitrogenized, soluble	22·1
Ditto insoluble	43·8
Mineral	3·6
Water	28·7
	100·00

Pea-straw. By BOUSSINGAULT.

Nitrogenized	12·55
Non-nitrogenized, soluble	21·93
Ditto insoluble	47·52
Mineral	6·00
Water	12·00
	100·00

Bean-straw. By WAY, 'Royal Agricultural Society's Journal.'

Moisture	14·47
Albuminous matter	16·38
Oil or fatty matter	2·23
Woody fibre	25·84
Starch, gum, &c.	31·63
Mineral	9·45
	100·00

Rye-straw. By Boussingault.

Nitrogenized	1·52
Non-nitrogenized, soluble	37·10
Ditto, insoluble	39·75
Mineral	2·93
Water	18·70
	100·00

Clover-hay.

Nitrogenous	10·29
Non-nitrogenous	62·63
Mineral	6·08
Water	21·00
	100·00

White Turnips, Swedes, Mangolds (by Voelcker), *and Carrots.*

	White Turnips.	Swedes.	Carrots.	Mangolds.
Nitrogenous	1·143	1·443	1·48	1·81
Non-nitrogenous	7·799	8·474	11·61	11·19
Ash	·628	·623	·81	·96
Water	90·430	89·460	86·10	86·04
	100·000	100·000	100·00	100·00

Gosfield, Halsted.

From the conflicting opinions of scientific men, based on chemical analysis, as to both the feeding and manuring value of straw, and the almost contradictory statements of other writers on this subject,—the large promises of direct profit held out by some from the combination of straw-chaff with richer food in cattle feeding, contrasted with the assertions of others that however high may be the true theoretic value of straw for feeding, still it will not answer to buy rich food for the purpose of mixing with straw-chaff,—we turn with satisfaction to the practical good sense of the author of the present Essay.

The highest service which can be at present rendered to agriculture is, perhaps, that of the practical man who, informing his mind, and shaping his observations by the light of scientific speculation, will address himself methodically to put things to the proof under his own eye; testing, measuring, and weighing, not estimating results, yet making due allowance for the influence which disturbing causes exercise on the *average* result as compared with the maximum effect which can be produced at some short and picked moment of time.

In this sense our author seems to be truly practical, and if he leans a little to the old-fashioned side, that is the safe side for him who is not unwilling to test and try well recommended

novelties. If his estimates differ from those of other recent writers, they may perhaps be found to square with a sober view of average results, when others are rashly generalizing from exceptional cases.

These pages are fully as valuable for the suggestions they offer as for the conclusions at which they arrive. Our author, indeed, gives us full means of estimating the amount of manure which may be made under a given course of feeding in boxes or in covered yards, in which respect his calculations may be of great service in aiding us to arrive at a standard for the composition and value of farm-yard manure,—a standard with which all other qualities of such manure must ultimately be compared and measured. But boxes and covered yards are hitherto the exception and not the rule. When, however, he comes to the point which most materially affects the majority of farmers, how far this problem is modified when the cattle are fed in open yards, or even when the litter is thrown out from stalls into such yards, our author does not venture to clench his statement; he has, however, at my suggestion, appended a note to his original Essay, in which he calculates approximately that the rainfall would add 464 tons of water to the 525 tons of manure on which it is supposed to fall.

This estimate is, however, subject to deductions; 1st, for overflow from the yards, and, 2ndly, from the effects of evaporation. It must, however, be borne in mind that the assumed dimensions of the yards are very small, such as are not often found except in connexion with modern buildings, where waste from overflow is carefully guarded against. If the buildings were old-fashioned, the area of the yards would probably be much larger, and the drippings from the roof would add considerably to the direct rainfall; these two sources of an increased supply of water would probably compensate for the overflow. Very little is known as to the amount of evaporation arising from a bed of straw, the top of which is comparatively dry; but, as the surface exposed is but small, and the situation sheltered, the loss of moisture from this cause is probably not great, especially during the winter months. Taking Mr. Evershed's calculation as it stands, without abatement, 200 tons of litter would, in open yards, furnish 989, or, in round numbers, 1000 tons of manure. Considering, therefore, that he calculates the amount of rainfall for yards only of such moderate area as seem best adapted to improved modern practice, it may be reckoned that, in the larger old-fashioned yards, the weight of manure to be carted is doubled by the rainfall.* This conclusion will be confirmed by

* The result will be the same if we allow for the employment of a *smaller* number of yards, and, consequently, fewer head of stock kept for a *longer* period.

regarding the subject from another point of view; that of the quantity of manure commonly reckoned on as ready for use on a farm of a given size. If reference be made either to the requirements of old-fashioned covenants when they prescribed the quantities of dung to be applied in the course of the rotation, or the estimates of practical men when they theorized on the quantity of manure proper to be applied to each crop, it will appear that, a liberal allowance being made for the bulk of straw grown per acre, that amount must be increased four-fold at least to supply the amount of dung required.

But not to refer to byegone estimates, I will only note that Mr. Morton, in his recent article, vol. xix. of Journal, p. 464, speaking of the horse labour performed on Whitfield farm, speaks of 1200 tons of dung being carted where only 120 acres of corn are grown. This would give 10 tons of dung as the produce of one acre of straw; or, supposing the litter, as assumed above, to contribute one-fifth of the bulk, and no straw at all to be consumed otherwise than as litter, we should require for this result an average yield of 2 tons of straw to the acre on autumn and spring corn alike,—assuredly a very high average. I think, therefore, that I may safely infer that in open yards the rainfall nearly doubles the bulk of the manure: the excrements, liquid and solid, representing 6 cwt. in round numbers,

the litter	,,	4 ,,	,,	,,
the rainfall	,,	10 ,,	,,	,,

in the composition of 1 ton of manure.

It is noteworthy that by using covered yards we do not so much diminish the quantity of manure which a farm can produce as alter the proportions of its constituent elements: in this latter case the litter furnishes less than one-fourth of the bulk, so that 200 tons of litter would provide for 850 tons of manure; whilst on the other hand the amount of the excrements, liquid and solid, would be doubled to attain this result, and the rain-water removed.

It may be interesting to consider what the size of a farm must commonly be which can furnish 200 tons of straw for litter, after other demands have been satisfied. The following calculations are made mainly for a light land farm, under the four-course system, as it is chiefly on such soils that a great breadth of straw is grown; and certainly for such the worth of straw, whether as fodder or litter, has a special importance. On these soils 200

Four yards filled the whole year round would, of course, give the same result as eight used only during six months. *Practically*, some modification will be made for the sake of economising buildings, if not labour; but, *theoretically*, it is easiest to carry out these calculations on the author's original hypothesis.

acres of corn would probably be required to furnish 200 tons of straw for litter; nor, if we attempt to strike an average for the whole kingdom, will these proportions be much changed. For first, as to wheat-straw, Stephens, vol. i. 1991, cites 1 ton 7 cwt. as Arthur Young's estimate, no account being taken of the weaker soils. He then quotes Scotch authorities, giving 1 ton 5 cwt. and 1 ton 76 lbs. per imperial acre as the results of their experience; and concludes by expressing his own opinion that 1 ton per imperial acre is too high an average for Scotland.

Mr. Morton, in one of his latest papers on the forces used in agriculture, has estimated an acre of a good wheat-crop, tied in sheaves, at 5000 lbs., which seems to be a well-considered and just estimate. Now if of this there be of grain 8 sacks, weighing 18 st. each, the corn alone would weigh 18 cwts. or 2000 lbs. nearly, leaving 3000 lbs. as the weight of the straw, or nearly 1 ton 7 cwt.; a result coinciding exactly with that of Arthur Young.*

With respect to barley and oat-straw, Stephens's estimates place them at about two-thirds and three-fourths, respectively, of the bulk of wheat-straw grown per acre, or 18 cwt. and $20\frac{1}{4}$ cwt. respectively.

We may, therefore, safely assume *on the average*, that one acre of wheat and one acre of spring-corn together will not yield more than 2 tons 10 cwt. of straw, or 250 tons from 200 acres of corn.

I come now to the consideration of the other sources of demand upon the straw-stack besides that of litter.

First we have cart-horses, consuming cut chaff:—our author speaks of 10 such horses; this would not be an adequate number for the extent of arable land we are contemplating: 13 would probably be required on an easy-working light soil—but if beasts on the average consume as much straw in the shape of fodder as horses, the result will be the same for 10 horses and 40 beasts as it would be for 13 horses and 37 beasts.

I find upon inquiry that in my cart-stables there was consumed, besides corn and a moderate allowance of hay, by the young horses 10 lbs. per day, and by some older mares 15 lbs., of cut wheat-straw and barley-chaff.

In winter the allowance of hay would be occasionally diminished, and considerably more straw eaten in consequence; on

* It is not clearly stated whether reaped or mown sheaves are intended, but this, though important in itself, does not so immediately affect the object now in view as might at first sight appear, because if the farm has not an ample supply of "haulm" for storing roots and other purposes, a greater deduction will have to be made from the total supply of straw to meet these demands.

the other hand, the short stuff from the barley-thrashing contributes considerably to the subsistence of the horses, and spares cut chaff, whether it may have been taken into account in the bulk of the barley crop, or not.

Now if 10 horses consumed 10 lbs. a-piece of chaff daily during say 8 months of 30 days (240 days), they would consume 10 tons 14 cwt. in all. I calculate therefore that they consume at least 1 ton of straw a-piece in the course of the year as cut chaff.

Next, in the case of cow-stock, when these are economically fed, in those parts of England where the proportion of arable land is large, not less than 1 ton per head of straw should be assigned to them as food; for a cow having little else to live upon will consume nearly 40 lbs. a-day of straw. Growing steers or heifers, moderately supplied with corn or cake (say 3 or 4 lbs.) and roots, without hay, would probably consume half this quantity of straw. Our author speaks of 14 and 18 lbs. of half hay half straw chaff as consumed by fatting oxen under cover, or in open yards. Mr. Horsfall's cows appear to be supplied with about 10 lbs. of wheat or oat straw per day, besides bean-straw and from 10 lbs. to 12 lbs. of hay.

From these and like premises I conclude that cattle will, on the average, eat with advantage 10 lbs. per day of straw-chaff for say 8 months, or 240 days; or 1 ton 1 cwt. in the year.

The question further arises, how much straw will be profitably consumed by sheep where a feeding flock is kept on 400 acres of arable?

I do not, on a hasty reference to Mr. Bond's excellent paper on Stock Farming (read before the Central Farmer's Club in 1858), find any distinct answer to this question; but the perusal of this paper led me to note, in my own book, the dietary of my flock of 13 score of ewes and lambs at the end of March, 1859. The ewes were then eating 5 fans of chaff with 1 sack of malt-combs; the lambs went forward, and had 4 stone of meal a-day besides. The fan represented approximately 6 bushels of 6 lbs. each, or 36 lbs.; so that the ewes ate 180 lbs. a day, or nearly $\frac{2}{3}$ lb. a-piece. Such an allowance, continued over 100 days, would require, as nearly as may be, 8 tons of straw. Besides the ewes I had about 120 ewe hoggets, which probably ate nearly $\frac{1}{2}$ lb. of cut chaff, when the old ewe ate $\frac{2}{3}$ lb. per day: 100 such hoggets would, at that rate, eat 5000 lbs. in 100 days, or upwards of 2 tons. 80 fatting wethers also consumed a considerable amount of cut straw-chaff with their cake; but as the amount of straw-chaff eaten by sheep varies very much with the weather and the temperature, I shall content myself by asserting that 8

tons of straw may be economically used during the winter, for sheep feeding, on a farm of 400 acres of arable land, where a breeding flock is kept.

Thus we shall require for the fodder of 50 head of large stock,

whether horses or beasts, at least	50 tons.
For sheep	8 ,,
For storing roots, when wheat is reaped, waste from thatching, making foundation of stacks, &c., say	5 ,,
Total	63 tons of

straw; or fully the excess over 200 tons which 200 acres of *average* corn can be expected to produce.

This note, like the statements which prompted it, is intended to be suggestive rather than conclusive; for throughout we are only opening, not deciding, the important question of the proper use of straw on a farm—a fitting subject for deliberate discussion in some future numbers of the Journal.

The article before us does not profess to dispose of the scientific question of the value of straw for fodder by calculations based on chemical analysis; neither can it appeal to well-conducted experiments, instituted for the purpose of determining the relative values of (say) hay and straw, whether bean or white straw, in combination with cake and roots. These remain among the desiderata of agriculture.

The scientific debate seems to lie chiefly within the following limits:—

No very broad or permanent distinction appears to exist between wheat, barley, and oat straw; that variety which is most congenial to the climate and soil of each district seems to be most palatable and most nutritious for the use of stock in that district. The amount of water in well-harvested straw seems to vary from 10 to about 14 per cent.;* the mineral ash from about 5 to 7 per cent. The two together may be taken to contain nearly 20 per cent., or one-fifth of the whole substance. Of the remainder some state less than 2 per cent., others more than 3 per cent., to consist of albumen, or, as others write, albuminous matter. Two and a half per cent. may be taken as a mean estimate.† There is besides a small quantity of oil, variously stated at from $\frac{1}{2}$ to $\frac{3}{4}$ of a lb. per cent.

Some readers will recollect that recently Professor Nesbitt stated at the Farmer's Club, that 2 per cent., or even 1 per cent.,

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* If an exceptional analysis gives from 25 to 30 per cent. of water, this may perhaps be accounted for by early cutting or want of the usual stacking.

† Stephens, when estimating the straw crop of an imperial acre of wheat at 3000 lbs., speaks of 40 lbs. (1·33) per cent. of gluten, a low estimate; whilst he assigns to "oil or fat" 100 lbs. (or 25 per cent.), a high estimate.

was the utmost extent of oil that could be found in wheat-straw; the above differences, therefore, lie within narrow limits.

But we have a residue of nearly 80 per cent. of carbonaceous matter, and it is about the feeding value of this matter that the conflict of opinion really takes place.

On the one side it is urged that the chief part of this matter is woody fibre, of little value, only one-tenth thereof being soluble in water, or capable of being digested; on the other side, that about half of these substances exist in the form of starch, sugar, and gum, capable of digestion and assimilation, and of immediate use for the supply of the organs of respiration as far as is required, besides being further available for the formation of fat.

It would be a task of considerable difficulty even to state the theories, according to which starch may be converted into sugar, or either of these into fat, within the animal economy. Certain chemical agents are more efficacious than simple water in rendering these carbonaceous substances soluble; and there *may* be juices in the animal economy, whether acid or alkaline, that produce *results* analogous to these within the stomach of the animal; moreover, some chemical processes, such as that of fermentation, if not carried too far, may assist and prepare the way for the digestive process within. It may be that the admixture of some other kinds of food with straw may conduce to the development of these gastric juices, and to some extent exercise a *condimental* influence on the digestive process.

Practical men long ago liked to have the straw chaff for the cart horses stored some time before use, so that it underwent a gentle heating. This process is now often carried further, whether by the bruising of the clover or grass and weeds which grow together with the barley in the thrashing, or by the admixture of water or small quantities of green clover or roots with the chaff when cut.

But however capable of digestion part of the tissues of the straw may be in themselves; however we may be learning to assist nature, by, in some rude manner, cooking this food; however even the admixture of other kinds of food with straw may aid the process of digestion as well as of nutrition, yet truly scientific men must hesitate before they admit that by some unseen unexplained process the obedient particles of oxygen, hydrogen, &c., *actually do* fly hither and thither, and re-arrange themselves just as we should wish them to do, for the formation of fat and oil; whilst practical men, however decidedly they may affirm that cut straw mixed with other food *is* serviceable already, however hopeful they may be that further

knowledge and experience will render it more serviceable, can hardly, from the results of their experience, support those estimates of the value of common straw, which are based on the above-named theories of nutrition: we cannot speak of oil and fat, starch and sugar, as certainly convertible substances,—if not convertible terms.

Thus far we have been speaking of the worth of wheat, barley, and oat straw, but there is perhaps a more important because a more valuable kind of straw, that of beans and peas, still to be noticed,—the former kind being specially worthy of attention from the greater breadth that is grown.

It may be worth while to compare Professor Way's analysis of bean-straw, as given by Mr. Horsfall in his Essay, with two analyses of hay derived from the same source.

	Bean-straw.	Hay, 1st Crop.	Hay, 2nd Crop.
Moisture	14·47	12·02	11·87
Albuminous matters	16·38	9·24	9·84
Oil and fatty matters	2·23	2·68	6·84
Starch and gum	31·63	39·75	42·25
Woody fibre	25·84	27·41	19·77
Mineral matter	9·45	8·90	9·43
	100·00	100·00	100·00

In these analyses several points are worthy of notice. First, the general similarity of the constituents of the bean-straw and the first crop of hay, with the important exception that the former is stated to contain 16 per cent. of albuminous matter, against only 9 in the latter; in either case a quantity widely differing from the 2 or 3 per cent. assigned to such substances in the analyses of wheat, barley, or oat straw.

Again, the difference between the first and second crop of hay should be observed, because it probably arose from the latter being cut before it arrived at full maturity; and similar variations would probably be found in the straw of cereals if cut at different stages of their growth. The increase of oil and fatty matter, starch, and gum, accompanied by a proportionate decrease of woody fibre, is very instructive, and would suggest as early cutting of all plants, for the sake of the fodder, as is compatible with the maturity of the grain.

But if, according to analysis, bean-straw would appear to approximate to the value of hay, if not to surpass it, how comes it that its merits have not been more generally recognised and appreciated?

The best answer will perhaps be found by pointing to the somewhat similar fate of rape-cake. Until Mr. Pusey, prompted probably by the teaching of chemical analysis, advocated the use of rape-cake as food, it was called oil-dust, and used almost exclusively as manure.

Mr. Pusey called attention to the fact that, examined under the recognised heads of chemical analysis, it was equal to linseed, then the only oil-cake in use for feeding, in its constituents.

The practical man has never been able to extract as much virtue out of it as out of linseed-cake (unless it be for dairy purposes), and that perhaps chiefly in consequence of its heating qualities and pungent taste, properties of which the analysis took no account. And yet its merits for food are so far recognised, that some farmers, myself among the number, think it almost a sinful waste to drill in nice fresh rape-cake as manure.

In like manner, toughness of structure and unpleasantness of flavour may have stood in the way of the use of bean-straw; yet the first objection may be overcome, and the second perhaps even converted into an auxiliary, in like manner as so many acids and bitters have been converted into stimulants.

On some few clay farms, where roots are scarce and a breeding flock is kept, the value of bean straw has been partially recognised as winter stover for the ewes, which, however, only pick over the dried leaves and smaller stalks at the barn-door; but in this manner, as also when it is furnished to cart horses for winter stover, but little of the crop is consumed as food, the great bulk being converted at once into manure.

No observations on this subject, however incomplete, especially if they would guard against exaggerated estimates as to the convertibility of straw into flesh and fat, can pass without notice the feeding experiments of Mr. Horsfall.

That gentleman has undoubtedly had great success with his stall-feeding, on a system in which straw plays a very important part; and undoubtedly he has rendered great service to agriculture, by the public-spirited manner in which he has been at the pains to communicate the results of his valuable experience to the world at large.

His practice combines two or three distinguishable and peculiar features:—

1st. His food is chiefly steamed; and much may depend on the sound discretion exercised, as to the amount both of moisture and of heat to be left in the mixture at feeding time.

When I have known the steaming process to be imperfectly tried, the animals became restless, and the food passed too quickly through them, probably from want of due precaution in these respects.

Again, the materials used by him under the denomination of straw are various, and generally blended together; so that it remains uncertain to which, or to the combination of which, the chief merit of the result is due.

He uses wheat-straw; and, again, the husks of the oat (not

oat-flight, but the husk or refuse of fine oatmeal); and, thirdly, bean-straw.

Speaking from conjecture, I should assign the lowest place to the first-named and the highest to the last-named ingredient, with an inclination, perhaps, to attribute the most benefit to that element which has been tested and tried the *least*, in accounting for an unusually successful result.

There is much that calls for further investigation in these experiments; but we may congratulate Mr. Horsfall on his success, and try to emulate it, with the assurance that the comparison of attempts, whether successful or the reverse, will ultimately disclose the point on which success hinges, if, as we can hardly doubt, that result be attainable.

The importance of the subject of the economical production of beef cannot be doubted at the present moment, when the system of fattening stock at a loss, with a view to being remunerated by an increased produce of grain, seems to be drawing to an end, whilst the demand for meat is on the increase.

The more a man feels assured that statements of direct profit by stall-feeding bullocks will not bear inspection, or, at the best, only apply to exceptional cases, the more anxious he must be that more economical methods of producing beef should be recognised, than those which have hitherto prevailed.

If we would see how, in theory, a high value may be assigned to straw, we need only take the hypothesis that it contains 30 or, as a maximum, 40 per cent. of gum, starch, sugar, &c., and that these substances are worth 1*d.* per lb.

One ton of straw would then contain $\frac{30}{100}$ of 2240 lbs. of starch, &c., which at 1*d.* per lb. would give us the following value: $\frac{30}{100} \times 2240d. = 3 \times 224d. = \frac{\cancel{3} \times 224}{\cancel{3} \times 4} = 56s.$ per ton; or, in the case of 40 per cent. of gum, starch, &c., $\frac{40}{100} \times 2240d. = 4 \times 224d. = \frac{\cancel{4} \times 224}{3 \times \cancel{4}} = 75s.$ nearly per ton.

If we are at all prepared for such results, we shall not demur to the phosphates in straw being valued quite as highly as when they are found in any other form.

We shall not dwell upon the improbability of any practical farmer buying potash at the price at which it is sold as an article of commerce.

We shall hardly pause to inquire why scientific writers are not now content with valuing nitrogen at 6*d.* per lb., the price it bore in the most palmy days of the nitrogen theory.

On the other hand, if carbonaceous matter be so valuable to the animal, we may rather demur to its utter depreciation in the shape of manure, as food for the plant; for the narrow-leaved grasses at nearly all the stages of their growth, and for the broader-leaved tribe at the time of their early development.—P. H. F.

Letter from Mr. Jonas, *communicating a Plan for Cutting and Storing Straw Chaff to the best advantage.*

My dear Sir, July 17th, 1860.

I have just invented a plan for cutting straw into chaff, which gives me much satisfaction. I have purchased of Mr. Maynard of Whittlesford, in this county, one of his powerful chaff-cutters, with sifting apparatus attached, which cutter I can work from a wheel or drum attached to my threshing-machine, which is driven by a 9 horse-power steam-engine at the same time that I am threshing corn. The straw, when delivered from the threshing-machine, is carried up an inclined plane by spiked rollers to a height of about 9 feet; it then comes down an inclined rack, nearly yelmed and ready for cutting into chaff. Three men yelm the straw, mixing with it a small quantity of green fodder, such as rye or tares. When cut into chaff, it is sifted and carried into an empty barn or chaff-house and well trodden down, and about 1 bushel of salt mixed with a ton of chaff, so as to cause a fermentation. All this is effected with no more manual labour than would be required to take away the straw and stack it in the ordinary manner. Within the last few days I have threshed and dressed the corn, and at the same time cut the straw into chaff from the produce of about 80 acres of wheat, at a cost, too, not exceeding 45*s.*, or 7*d.* per acre for cutting the straw produced on an acre of wheat. This chaff I shall not use until next October, when I purchase my beasts for winter grazing, and none but those who have tried this plan of old chaff so managed, as compared with fresh-cut chaff, can believe the advantage in value of the old chaff for feeding stock. I can work off the produce of about 8 acres of good strong wheat per day, thus cutting about 800 fans per day, the chaff being cut shorter and better than by the hand-box.

Three men yelm the straw and feed the chaff-cutter, and if the threshing-machine be placed near the barn or chaff-house which is to be filled, two men can carry the chaff into the barn; two or three boys should tread it down close, so as to cause it to heat. The only extra expense is for from 4 to 5 cwt. of coal per day. If, however, the straw is stacked as threshed and cut into chaff afterwards, the expenses of cutting and sifting with Maynard's chaff-cutter would be as follows:—

	£.	s.	d.
1 man to move the straw from stack to men to yelm	0	2	0
4 men to yelm straw	0	8	0
2 men to carry away chaff	0	4	0
3 lads to tread chaff down, 6*d.*	0	1	6
Hire of engine and chaff-cutter (this includes 1 man to feed chaff-cutter and engine-man)	1	10	0
Coals, 5 cwt.	0	4	6
Water, carting	0	2	0
	£2	12	0

This will cut from 600 fans * to 900 fans per day, according to the length of cut: the first cut being about 3-16ths of an inch in length, the latter about 3-8ths. The cost would be, the very short cut, 1*d.* per fan; the latter cost 1-3rd of a penny per fan; but, by cutting the chaff at the same time you thresh, you save 47*s.* per day, or, in fact, cut 800 fans for 4*s.* 6*d.*

Yours faithfully,

P. H. Frere, Esq. Samuel Jonas.

* Mr. Jonas reckons a fan of chaff to measure 5 bushels, and to weigh 28 lbs. —P. H. F.

X.—*Statistics of Live Stock and Dead Meat for Consumption in the Metropolis.* By Robert Herbert.

For many months past the all-important question of production and consumption of stock in the United Kingdom has formed the topic of serious discussion amongst all classes of society. On the one hand, it has been contended that there is an absolute scarcity both of beasts and sheep in the country; on the other, that this scarcity is the result of a system of feeding which is calculated to keep prices at an unusually high range. When we consider the great interests involved in the subject of production, the enormous demands upon the resources of our graziers, and the rapid increase in the population, together with the increasing prosperity of the industrial classes, this question requires more than ordinary attention at our hands. In the first place then, let us inquire into the causes which have led to the recent excitement in the demand for beasts, not only in London, but throughout the provinces; and further, whether the grazing community have not acted upon a false principle, which may eventually be prejudicial to the interests of the consumers.

Now it may be assumed that not a few of our original breeds have fallen off considerably in number even in our best districts; but at the same time it may be remarked that they have given place to a race of animals cross-bred, chiefly between the Scots and Short-horns. In point of fact, crossing has now become so general, that fully half the beasts disposed of in our various markets consist of other than pure breeds. That the new system has paid remarkably well is quite evident from its rapid extension, and from the enormous weight which the crosses have attained in a much shorter period than the pure-bred animals.

Early maturity—so long aimed at by the largest breeders—has certainly made such progress as to awaken inquiry, if not anxiety, regarding the future existence of those races of stock which for so long a period have supplied our enormous consumption. We have observed that early perfection in beasts has yielded large profits. On this head no doubt can possibly exist; but the question is, has it produced an increased supply of really consumable food? Our impression is that, although most of the crosses, especially those from Scotland, have yielded large quantities of fat, still if we take any given number of beasts, and compare them with breeds which were disposed of some fifteen years since for slaughtering purposes, the weight of meat has not diminished in consequence of the increased amount of fat.

How, then, it may be asked, do we account for the present

enormously high range in the value of beasts compared with that of many former periods? We have now open ports for the admission of live stock; we import largely, and apparently are rapidly draining the Continent of every head of stock that can possibly be spared, and all this without any positive advantage to the consumers, so far as price is concerned. We must bear in mind two features in the trade which will at once explain our position, and show beyond a doubt that future prices are likely to rule high: first, the rapid increase of our population; and, secondly, a consumption large beyond all former precedent in proportion to that population. To meet the demand thus enormously increased, stock has been prematurely forced for sale, and in too many instances disposed of immediately on its becoming marketable.

Here then we perceive a state of things for which there is no positive remedy; and unquestionably it can only be met by a decreased consumption of animal food—an event not likely to arise except in periods of distress amongst the industrial classes, arising from foreign competition or from over-production at home. In proof that high currencies must prevail for a considerable period, we may observe that the rapidity with which beasts have of late years been disposed of has, to some extent, reduced the available supplies, not only in England, but likewise in Ireland and Scotland; whence it follows that if consumption continue to advance steadily as it has done of late, any considerable fall of prices is out of the question. At the present time the best Scots and crosses disposed of in the metropolitan market are worth fully 5*s.* 4*d.* per 8 lbs. That quotation, if stock were in abundant supply in the grazing districts, would speedily increase the arrivals; but, in order to prove that scarcity really exists, we may observe that beasts have been purchased in the metropolis at these high rates for consumption in Birmingham, Manchester, Liverpool, and Dublin, to such an extent that at one period London was absolutely suffering from the deficiency thus occasioned.

Again, owing to the want of food, large numbers of our second-rate breeds have been disposed of in poor condition, but yet at such high quotations, that they did not much influence prices. In all the provincial markets stock has come forward slowly; enormous prices have been paid for it, and the jobbers have found great difficulties in carrying on their operations for supplying London with food. The conclusion at which we feel justified in arriving is, that great inroads have been made upon the supply of stock; that consumption is in excess of our past rate of production; and that consequently we can hardly anticipate a range in value much below present prices.

We have now to consider the question of supply as it

bears upon that of sheep. Let it not be assumed that we profess to understand the flockmasters' business better than themselves; but undoubtedly there are questions in connexion with it which require serious consideration. It is well known that the "in-and-in" system of sheep-breeding has become a pretty general one, more especially in favoured districts.* It is equally well known that attention has been shown to a description of stock exhibiting great aptitude to fatten; and in this way crosses have become more and more numerous. Have they, we may inquire, produced an increased quantity of meat? Probably not. We believe that the forcing system has destroyed large numbers of sheep which, under ordinary circumstances, would have been kept longer on the land; and, further, that although many breeders have kept up the shape of their animals remarkably well, and have in many instances realised large profits, the end aimed at, viz., the production of fat in a brief period, must tend to high quotations. In a comparative sense, the sheep now sold in our markets carry a very moderate amount of consumable food. Be it observed that we are not alluding either to Downs or half-breds, but to Lincolns, Leicesters, Kents, and crosses between other heavy breeds. If we could find meat increasing in the same ratio as fat, we should find it wholly unnecessary to dwell upon the future otherwise than with feelings of satisfaction at what has been accomplished: as it is, there is much reason to apprehend that unless the old proportions of fat and lean are restored, and the supply largely increased, we shall not be able to keep pace with the demand which, at the present time, threatens to render us more and more dependent upon the foreigner, whose producing energies are now, if we mistake not, taxed to the utmost.

But how are we to effect changes in breeding and feeding in order to arrive at results which, nationally speaking, are highly important in their character? At the present time the feeders of sheep contend that they are compelled to keep pace with the spirit of the times; that nothing short of rapid production can be a source of profit to them; and that to keep stock longer upon the land than is absolutely necessary would, with the competition going on, be attended with absolute loss. Doubtless there is much truth in these statements, but they do not, as we imagine, go to the bottom of this question, which has assumed dimensions which make it one of national importance.

We do not attach much weight to the stated determi-

* Does not this remark apply rather to fancy stock, than to the general supply on which markets mainly depend?—P. H. F.

nation on the part of a portion of the labouring classes to abstain from the consumption of meat until prices shall have declined to a lower range. Even as it is, nearly all inferior joints are disposed of at a rate which is a loss to the butcher, so that the effect of our present high prices falls first and chiefly on the upper and middle classes of society, who buy the prime joints at prices further enhanced by the difficulty of disposing of inferior joints, and secondly, on the butcher, who, of late, has hardly derived any profit from his trade. The rise in price is chiefly due to changes connected with the comparative prosperity of our artizans ; but the burden has fallen even more severely on others than on them.

Higher wages, extraordinary activity in commerce, and a teeming population have, we have no hesitation in saying, not only reduced the available supplies of stock in the country, and introduced a system of breeding different from that of some twenty years since, but they have placed the country in a position from which it seems difficult to escape. We need not, perhaps, enter into particulars to prove that wages are now higher, and that the population has increased ; but we may refer to one fact which, at once, is conclusive as regards our commercial greatness. The "official" value of our imports and exports of produce and manufactures, in 1859, was nearly 450,000,000*l.* sterling, against about 220,000,000*l.* in 1839. In the past six years we have exported over 160,000,000*l.* in bullion, and fully that enormous quantity has been imported. Here, then, we see a state of prosperity without a parallel in the history of any country. This prosperity must, of course, "be fed," and it remains for our graziers and breeders to determine how far, and by what means, they can increase the supply of animal food to keep pace with the wants of the times.

There is another point to which we may here allude, as tending to keep up the value of live stock, viz., the enormous price of tallow in our markets. The operations of the speculative class in Russia, in 1859, prevented the usual quantities of tallow from being shipped to England, and the result was, that at one period the quotations for Siberian qualities in London were as high as 64*s.* per cwt. The decline in the consumption produced a fall of fully 10*s.* per cwt. ; but owing to the scarcity of home-made tallow a portion of the decline has been recovered. Rough fat has of course fluctuated with the value of tallow. In the early part of the year the first-named article was worth 3*s.* 4*d.*, now it is selling readily at 2*s.* 9½*d.* per 8 lbs. Thus it will be perceived that a refuse has realised the value of good consumable food in ordinary periods of abundance. If fat is to continue at a high

figure meat will unquestionably be dear in price; but much will depend upon the ability of the speculators to hold tallow, and the value of money in the discount market.

Supplies, Demand, and Value, during the past Six Months.

Notwithstanding that the total number of beasts exhibited and disposed of in the metropolitan cattle-market in the last six months has been a full average one, viz.—114,702 head against 113,373 head in the corresponding period in 1859, and 111,592 in 1858, prices, from causes to which we have already alluded, have ruled unusually high. The average value of the best Scots has been 5*s.* 6*d.*, against 5*s.* in the previous six months, and 4*s.* 6*d.* in 1858. But here we may observe that at least a moiety of the various breeds has been disposed of in little more than a half-fat state, and hence the actual supply of meat has been trifling. The same remark may be applied to sheep, especially to the long-woolled qualities. Compared with last year—taking the average of the six months—the value of that description of stock has advanced from 4*d.* to 6*d.* per 8 lbs., though at one period the rise was much greater, viz., 1*s.* to 1*s.* 4*d.* per 8 lbs. The annexed returns show the total supplies exhibited, the quarters from whence they were derived, and the prices at which they were disposed of:—

Supplies of each kind of Stock Exhibited and Sold during the first Six Months of the following Years:—

	1855.	1856.	1857.	1858.	1859.	1860.
Beasts	113,089	115,115	112,309	111,592	113,373	114,702
Cows	2,440	2,977	2,682	2,917	2,977	2,904
Sheep and Lambs	651,600	636,030	536,790	588,758	668,702	662,030
Calves	8,610	6,125	8,420	8,878	7,272	9,515
Pigs	16,590	15,344	13,240	13,096	14,869	14,201

"District" Bullock Supplies.

	1855.	1856.	1857.	1858.	1859.	1860.
Northern Districts ..	600	900	..	4,000	4,000	4,000
Eastern Districts	54,989	51,700	60,500	66,890	67,460	68,520
Other parts of England	12,530	13,850	14,490	14,560	19,090	21,420
Scotland	9,827	10,008	8,860	8,456	10,030	5,033
Ireland	4,000	3,400	2,700	4,820	2,217	1,477
Foreign	13,612	7,830	9,238	5,649	7,580	9,058

Average Prices of Beef and Mutton.

	1855.	1856.	1857.	1858.	1859.	1860.
BEEF:—	*s. d.*	*s. d.*	*s. d.*	*s. d.*	*s. d.*	*s. d.*
Inferior	3 2	3 0	3 2	3 0	3 2	3 6
Middling	4 0	3 10	4 0	3 10	4 0	4 6
Prime	4 10	4 8	5 0	4 6	5 0	5 6
MUTTON:—						
Inferior	3 2	3 0	3 10	3 2	3 4	3 10
Middling	4 2	4 0	5 0	4 2	4 8	5 2
Prime	5 4	5 2	6 0	5 2	5 10	6 2

From the above returns it will be seen that average *number* of beasts has been drawn from our grazing districts; that we have drawn extensively upon foreign resources; but that the arrivals both from Ireland and Scotland have considerably fallen off. In reference to the value of lambs, we may state that at one period it was 8*s.* per 8 lbs. for the best Down breeds, now it is 7*s.* Both calves and pigs have ruled high; the top figure for the former having been 6*s.*, the latter 5*s.* 4*d.* per 8 lbs. to sink the offal.

In a comparative sense the arrivals of meat up to Newgate and Leadenhall, both from Scotland and different parts of England, have fallen off considerably. Prices have, consequently, kept pace with the rise in the live markets; but our impression is, that they have seen their highest range for the year, and that they will tend to stimulate the production of stock both in the United Kingdom and on the Continent.

5, Argyle-square, St. Pancras, London.

XI.—*Report of Experiments on the Growth of Red Clover by different Manures.* By J. B. LAWES, Esq., F.R.S., F.C.S., and Dr. J. H. GILBERT, F.R.S., F.C.S.

PART I.

FEW questions in connexion with agriculture have excited more attention, or have been the subject of a greater variety of explanations, than the failure of Red Clover. It certainly seems somewhat strange that, whilst some of our farm crops can be grown year after year, or in pretty close succession, on the same land for a considerable period of time, and, for what we yet know to the contrary, continuously, others will only succeed when some years have elapsed since the same description of crop was grown.

In works on agriculture the failure of clover is accounted for in a great number of ways, among which the following assumed causes may be mentioned:—

Exhaustion of the soil;
The growth of parasitic plants, which strike their roots into the clover and exhaust its juices;
Destruction by insects;
The injurious influences arising from the matter excreted by the roots of the former crop, or from the decay of the roots themselves;
The growth of the young plant under the shade of a corn crop.

Although the Clover crop may be found to suffer from more than one of the above-enumerated causes, the phenomena which present themselves are nevertheless by no means satisfactorily explained; and, so far as prevention is concerned, our knowledge is pretty nearly limited to that of the fact, that the only chance of growing the crop with success is to allow a certain number of years to elapse before repeating it on the same land. We have experimented for some years on the subject with a view to ascertain, if possible, by what means the crop can be grown year after year on the same land. In this we have not been successful. Still it is thought that a short account of the course pursued, and of the results obtained, may be of service, by showing some of the difficulties involved in the inquiry, and by limiting or indicating the direction of future investigations.

Experiments on this farm have satisfactorily shown that some of the crops which are generally grown in rotation, will yield a large amount of produce year after year on the same land, on the application of certain constituents as manure. Thus, a part of the same field, in which the experiments on Clover now in question were made, has grown barley for ten years in succession, and on some plots large crops have always been obtained. In like manner, in an adjoining field, wheat has been successfully grown for sixteen years consecutively. Nor is there at present anything in the results to lead to the supposition that these crops might not be so grown continuously for a century. The results of somewhat similar experiments with Clover are very different, as the records we are about to give will show.

In 1847 a heavy crop of swedish turnips was grown by farm-yard manure and superphosphate of lime, a large proportion of which was carted from the land. In 1848 barley and Red Clover were sown; and in the spring of 1849 four acres were set apart for experiment. These were divided into a number of plots, which were manured as shown in Table I.

EXPERIMENTS on the GROWTH of RED CLOVER by DIFFERENT MANURES.

TABLE I.—Showing the DESCRIPTION and AMOUNT of MANURES employed, and the AMOUNT of PRODUCE obtained per Acre. FIRST SEASON, 1849.

Plot, Nos.	MANURES per Acre.	PRODUCE per Acre. 3 Cuttings—June 26 and 28; August 6; October 19. Weights Fresh, as Cut.				Weights calculated as Hay.*			
		tons.	cwts.	qrs.	lbs.	tons.	cwts.	qrs.	lbs.
	SERIES 1.—Unmanured, or with Mineral Manures alone.								
1	Unmanured	14	1	3	6	3	15	0	14
2	Superphosphate of Lime (150 lbs. Bone-ash and 112½ lbs. Sulphuric Acid, sp. gr. 1·7)	15	5	2	16	3	19	3	4
3	300 lbs. Sulphate of Potash	17	19	2	18	4	17	2	8
4	300 lbs. Sulphate of Potash, and "Superphosphate of Lime"	16	19	3	5	4	9	2	20
5	Mixed Alkalies (300 lbs. Sulphate of Potash, 100 lbs. Sulphate of Soda, and 100 lbs. Sulphate of Magnesia)	18	1	0	0	4	11	0	21
6	"Mixed Alkalies," and "Superphosphate of Lime"	16	6	3	21	4	12	2	26
	SERIES 2.—With Ammonia Salts alone, or in addition to Mineral Manures.								
1	100 lbs. each, Sulphate and Muriate of Ammonia	14	17	0	18	3	18	1	26
2	100 lbs. each, Sulphate and Muriate of Ammonia, and "Superphosphate of Lime"	14	8	0	16	3	18	0	1
3	100 lbs. each, Sulphate and Muriate of Ammonia, and 300 lbs. Sulphate of Potash	13	10	1	17	3	11	0	11
4	100 lbs. each, Sulphate and Muriate of Ammonia, and 300 lbs. Sulphate of Potash and "Superphosphate of Lime"	17	12	2	22	4	9	3	16
5	100 lbs. each, Sulphate and Muriate of Ammonia, and "Mixed Alkalies"	17	10	0	22	4	11	2	20
6	100 lbs. each, Sulphate and Muriate of Ammonia, "Mixed Alkalies," and "Superphosphate of Lime"	17	10	0	2	4	12	0	2
	SERIES 3.—With Rape-Cake.								
1, 2, 3, 4, 5, 6	1000 lbs. Rape-Cake	12	17	1	23	3	7	2	25

* On the supposition that the Hay would consist of 5 parts dry substance, and 1 part water.

As our object in the present short communication is to do little more than call attention to the great variety of conditions under which the Clover-plant has failed, we shall not enter, on this occasion, into any detailed examination of the action of the various manures, in regard either to the amount of produce obtained under the different circumstances of season and manuring, or to the chemical composition of the plant. It will be sufficient to point out, that, in every case, the crop of this first year of the experiment was a very large one; amounting, in three cuttings, to about 14 tons of fresh green produce, equal to about $3\frac{3}{4}$ tons of hay, without the addition of manure of any kind; and where sulphate of potash, sulphate of potash and superphosphate of lime, or sulphates of potash, soda, and magnesia, were employed, 17 to 18 tons of green produce (equal to from about $4\frac{1}{2}$ to nearly 5 tons of hay), per acre were obtained. When to the mineral manures were added those salts of ammonia which so greatly increase the produce of our Cereal crops, the produce of this Leguminous plant was upon the whole less than where the mineral manures were used alone. It will be seen too, that the rape-cake (Series 3) gave a smaller crop than either the mineral manures alone, or the mineral manures together with ammoniacal salts.

After the third cutting of Clover (1849) had been taken from the land, it was ploughed up and sown with wheat, about the middle of November, without any further manuring. The produce—corn, straw, &c.—is given in Table II.

It will be observed that the weight per bushel of corn, of this wheat-crop, scarcely in any case reached 58 lbs.; and in its case, as well as in that of an adjoining experimental field, the proportion of corn to straw was rather low. The wheat grown after the Clover on the unmanured plot gave, however, $29\frac{1}{2}$ bushels of corn, or 14 bushels more than was obtained in the adjoining field, where wheat was grown after wheat without manure. This result is quite consistent with that obtained in ordinary farm-practice. It should be observed, however, that in the unmanured Clover-crop of 1849, very much larger quantities both of mineral constituents and of nitrogen were taken from the land, than were removed in the unmanured wheat-crop in the same year, in the adjoining field; and it is seen that, notwithstanding this, the soil from which the Clover had been taken, was in a condition to yield 14 bushels more wheat per acre than that upon which wheat had been previously grown.

Where salts of ammonia had been applied, in addition to the mineral manures, for the Clover of 1849, there was an average of about 2 bushels more wheat per acre in 1850, than where the ammonia-salts had not been supplied.

On

EXPERIMENTS on the GROWTH of RED CLOVER by DIFFERENT MANURES.

TABLE II.—Showing the PRODUCE of WHEAT, without direct Manure, after the removal of 3 Cuttings of RED CLOVER, from plots of Land variously manured. HARVEST 1850.

Plot, Nos.	MANURES per Acre, applied in 1849 for the CLOVER.	PRODUCE OF WHEAT per Acre, &c. Dressed Corn.		Weight per Bushel of Dressed Corn.		Total Corn.	Total Straw, &c.	Total Produce (Corn and Straw).
	SERIES 1.—Unmanured, or with Mineral Manures alone, in 1849.							
		Bush.	Pks.	lbs.	ozs.	lbs.	lbs.	lbs.
1	Unmanured	29	2	55	6	1792	3512	5304
2	Superphosphate of Lime (150 lbs. Bone-ash and 112½ lbs. Sulphuric Acid, sp. gr. 1·7)	32	2¾	56	14	2029	3811	5840
3	300 lbs. Sulphate of Potash	30	1¼	55	4	1867	3906	5773
4	300 lbs. Sulphate of Potash, and "Superphosphate of Lime"	33	3¼	56	2	2097	4197	6294
5	Mixed Alkalies (300 lbs. Sulphate of Potash, 100 lbs. Sulphate of Soda, and 100 lbs. Sulphate of Magnesia)	31	1	56	6	1962	4088	6050
6	"Mixed Alkalies," and "Superphosphate of Lime"	33	1	55	15	2264	4176	6440
	SERIES 2.—With Ammonia Salts alone, or in addition to Mineral Manures, in 1849.							
1	100 lbs. each, Sulphate and Muriate of Ammonia	32	1¾	57	4	2058	3917	5975
2	100 lbs. each, Sulphate and Muriate of Ammonia, and "Superphosphate of Lime"	32	3	57	0	2062	3720	5782
3	100 lbs. each, Sulphate and Muriate of Ammonia, and 300 lbs. Sulphate of Potash	32	3	56	15	2031	3842	5873
4	100 lbs. each, Sulphate and Muriate of Ammonia, and 300 lbs. Sulphate of Potash and "Superphosphate of Lime"	36	0¾	57	11	2292	4296	6588
5	100 lbs. each, Sulphate and Muriate of Ammonia, and "Mixed Alkalies"	35	1	58	1	2253	4135	6388
6	100 lbs. each, Sulphate and Muriate of Ammonia, "Mixed Alkalies," and "Superphosphate of Lime"	33	2¼	56	11	2093	3967	6060
	SERIES 3.—With Rape-Cake, in 1849.							
1	1000 lbs. Rape-Cake	27	0¾	56	10	1781	3520	5301
2	1000 lbs. Rape-Cake	30	1¾	57	13	1916	3692	5608
3	1000 lbs. Rape-Cake	25	2¾	55	15	1695	3468	5163
4	1000 lbs. Rape-Cake	29	2¼	56	10	1910	3822	5732
5	1000 lbs. Rape-Cake	31	3	57	9	2002	3795	5797
6	1000 lbs. Rape-Cake	30	0	56	14	1891	3342	5233

On comparing the amount of produce of wheat in these experiments, with that obtained in the adjoining field on the plots where large quantities of both mineral and nitrogenous manures were employed, there is every reason to believe that it would have been considerably greater had the season been more favourable. For, as it was, the yield after the Clover, was fully equal to that in the other field where very large amounts of manure were used. It would appear, therefore, that the crop had reached the limit of development which the characters of that particular season admitted of.

In the spring of 1850, Red Clover was sown upon the young wheat; but after the removal of the corn-crop, it was considered that there was not a sufficient plant of Clover to stand. It was, therefore, ploughed up, re-manured, and re-sown with Clover, as described below.

The same mineral manures as were applied for the Clover-crop of 1849, were re-sown on the same spaces—that is, both on the plots which before received mineral manure alone, and on those which had received both mineral manure and ammoniacal-salts. The application of ammoniacal salts was, however, not repeated; but, in order to secure a greater variety of manuring, a portion of the plots which had before been dressed with mineral manure alone (Series 1 of Tables I. and II.), and an equal portion of those formerly manured with both mineral manure and ammoniacal salts (Series 2 of Tables I. and II.), were now manured with a compost of dung and lime (in addition to the newly-supplied mineral manures), at the rate of 15 tons of farmyard-manure, and 60 bushels of fresh lime, per acre. The dung and lime were mixed, and then clamped on the respective plots, some time before being spread and ploughed into the land. The object of this experiment was to get a more rapid decomposition of the dung, with possibly the formation of certain organic compounds, somewhat of the nature of humus or its derivatives. For similar reasons the portion of the experimental land manured with rape-cake in 1849, was now divided, and manured with soot; with soot and lime; or with soot, lime, the mixed alkalies, and superphosphate of lime.

Instead therefore of three Series of plots as formerly, the experimental land was now divided into four Series, as under:—

Series 1. With mineral manure alone (or unmanured on Plot I.), as in 1849.

Series 2. With mineral manure (or without, on Plot I.), and a mixture of farmyard-manure rotted with lime, in addition; half of each plot having, in 1849, the mineral manure alone, and the other half the mineral manure and ammoniacal-salts.

Series 3. With mineral manure alone (or without it, on Plot I.), ammoniacal-salts having been also applied in 1849.

Series 4. With soot, soot and lime, or soot, lime, and the mixed mineral manure; these plots having been manured with rape-cake in 1849.

With these explanations, the detailed statement of the manures applied, and of the produce obtained, given in Table III., will be at once understood. It may be added, however, that on most of the plots of Series 1, 2, and 3, the mineral manures (mixed with clay-ashes) were sown on January 25, 1851. On the same day the dung and lime were mixed and clamped on the plots of Series 2; the mineral manures of Plots V. and VI., Series 2, being mixed with the dung and lime, instead of being sown at once as in the other cases. The heaps of dung and lime were turned over on the 10th of February, and spread on April 28. The manures of Series 4 (soot, lime, &c.) were mixed into heaps on the respective plots on January 27, and sown February 3. The whole of the land was ploughed immediately after spreading the dung and lime, on April 28; and, being brought to a proper tilth, Red Clover seed was drilled, on May 8, in rows 8 inches apart. The plants came up well, and the crop was cut on September 3. The details of the manuring and produce are given in Table III.

It was not to be expected that the produce obtained in September, from seed sown only on May 8 of the same year, would be in any way equal to that yielded from seed sown, as is usually the case, in the spring of the preceding year. Accordingly, it is seen that the maximum crop (Plot 7, Series 2) amounted to only 5 tons 9½ cwts. of green-clover, equal to about 1 ton 6 cwts. of hay.

On comparing the produce of Plots 1, 2, and 3, of Series 1, 2, and 3, with that of Plots 4, 5, and 6, of the same Series, it will be seen that the crop on the latter was about double that on the former; the Plots 4, 5, and 6, which thus give so much the higher amounts of produce, being those which received as mineral manure—sulphate of potash, and superphosphate of lime—sulphates of potash, soda, and magnesia—or sulphates of potash, soda, and magnesia, and superphosphate of lime together.

The dung and lime (Series 2), and soot and lime (Series 4), produced but very little effect. The greatest increase obtained by the addition to the mineral manures of the dung and lime compost (at the rate of 15 tons of dung and 60 bushels of lime per acre), beyond the produce from the corresponding mineral manures used alone, was only equal to 4 or 5 cwts.

In the autumn, after the crop was cut, the plant grew remarkably

EXPERIMENTS on the GROWTH of RED CLOVER by DIFFERENT MANURES.

TABLE III.—Showing the DESCRIPTION and AMOUNT of MANURES EMPLOYED, and the AMOUNT of PRODUCE OBTAINED, PER ACRE. SECOND SEASON, 1851.

Plot Nos.	MANURES, per Acre, for the Clover of 1851.	PRODUCE, per Acre, Cut September 1 and 3, 1851. Weight Fresh, as Cut. tons.	cwts.	qrs.	lbs.	Weight, calculated as Hay. tons.	cwts.	qrs.	lbs.
	SERIES 1.—Unmanured, or with Mineral Manures alone (the same as in 1849).								
1	Unmanured	1	15	2	8	0	8	3	5
2	Superphosphate of Lime (150 lbs Bone-ash and 112½ lbs. Sulphuric Acid, sp. gr. 1·7)	1	1	0	12	0	5	1	9
3	300 lbs. Sulphate of Potash	2	4	0	24	0	11	1	0
4	300 lbs. Sulphate of Potash, and "Superphosphate of Lime"	4	0	0	19	0	19	1	23
5	Mixed Alkalies (300 lbs. Sulphate of Potash, 100 lbs. Sulphate of Soda, and 100 lbs. Sulphate of Magnesia)	4	12	1	12	0	19	2	25
6	"Mixed Alkalies," and "Superphosphate of Lime"	4	17	3	26	1	2	2	19
	SERIES 2.—With Farmyard Manure and Lime, either alone, or with Mineral Manures in addition (Ammonia-salts, &c., on Half of each Plot in 1849).								
1	15 tons Farmyard Manure with 3720 lbs. Lime	2	9	0	11	0	11	2	25
2	15 tons Farmyard Manure with 3720 lbs. Lime, and "Superphosphate of Lime"	2	4	2	13	0	10	2	23
3	15 tons Farmyard Manure with 3720 lbs. Lime, and 300 lbs. Sulphate of Potash	2	18	2	12	0	13	3	12
4	15 tons Farmyard Manure with 3720 lbs. Lime, and 300 lbs Sulphate of Potash, and "Superphosphate of Lime"	5	1	0	0	1	3	1	7
5	15 tons Farmyard Manure with 3720 lbs. Lime, and "Mixed Alkalies"	4	12	1	12	1	0	2	1
6	15 tons Farmyard Manure with 3720 lbs. Lime, and "Mixed Alkalies," and "Superphosphate of Lime"	5	5	1	4	1	3	2	0
7	15 tons Farmyard Manure with 3720 lbs. Lime, and "Mixed Alkalies," and "Superphosphate of Lime"	5	9	2	0	1	6	0	2
	SERIES 3.—Unmanured, or with Mineral Manures alone (Ammonia Salts alone, or with Mineral Manure, in 1849).								
1	Unmanured	1	18	2	25	0	9	1	4
2	"Superphosphate of Lime"	1	16	2	9	0	9	0	7
3	300 lbs. Sulphate of Potash	2	13	0	21	0	13	0	25
4	300 lbs Sulphate of Potash, and "Superphosphate of Lime"	4	8	3	14	1	0	0	0
5	"Mixed Alkalies"	4	10	2	21	1	0	0	27
6	"Mixed Alkalies," and "Superphosphate of Lime"	4	16	2	9	1	3	0	20
	SERIES 4.—With Soot, &c. (Rape Cake, in 1849).								
1, 2	1240 lbs. Soot	2	10	3	2	0	12	2	12
3, 4	1240 lbs. Soot and 1240 lbs. Lime	3	18	2	25	0	18	3	16
5, 6	1240 lbs. Soot, and 1240 lbs. Lime, "Mixed Alkalies," and "Superphosphate of Lime"	4	18	3	1	1	2	3	27

ably well, and was very regular throughout the plots. It was therefore left without further treatment during the winter of 1851-2.

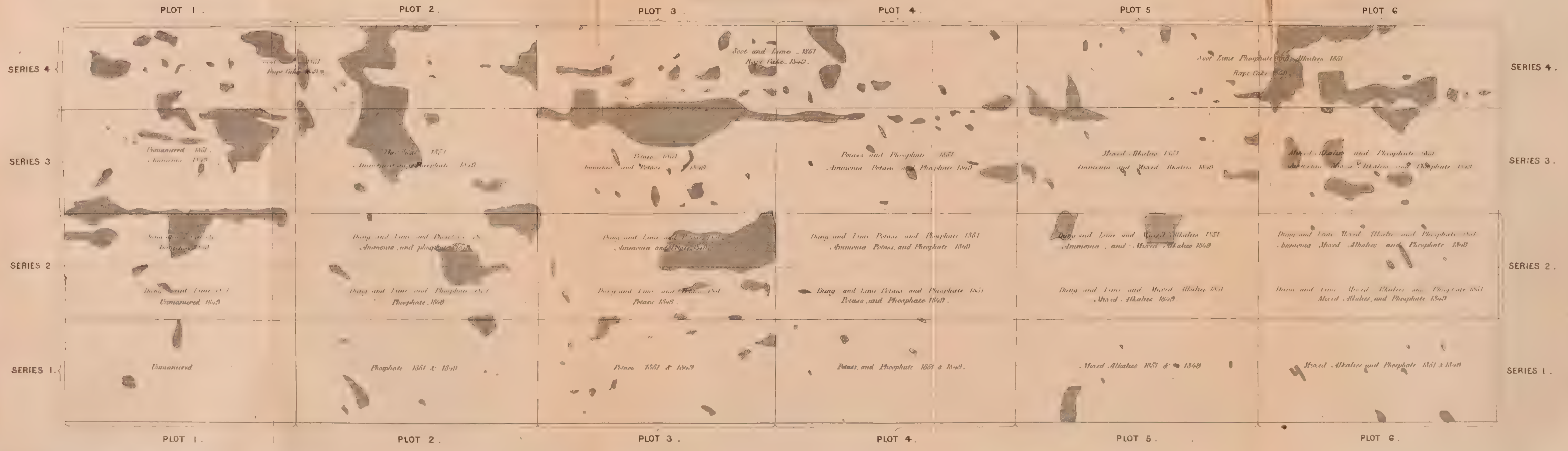
Those who have paid attention to the spread of disease in clover, on land which is said to be "clover-sick," will have observed that, however luxuriant the plant may be in the autumn and winter, it will show signs of failure in March or April, the spread and final limit of the disease being, however, subject to great variation. In the month of March, 1851, symptoms of failure became apparent on many of the experimental plots. It was quite plain however that the spread of the disease was much more extensive and rapid on some of them than on others. And, since such a great variety of manures had been employed, it was thought very desirable to determine the effect of the different conditions of growth so provided, in aggravating, or lessening, the progress of the failure. Accordingly, on April 15, when the disease had extended pretty nearly to its limits, and the surviving plants were showing vigorous growth, a plan of the plots, with the patches where the plant had died off, carefully laid down by measurement, was made, of which the annexed Diagram is a copy.

The black lines show the division of the plots at the time the plan was taken. The dotted line, along the centre of the plots marked Series 2, shows the division between the portion which was manured with ammonia-salts in 1849, and that which was not so manured; and, as already described, the plots of "Series 2," of 1851 and afterwards, to which farmyard-manure and lime were then applied, comprised a portion of land on each side of the line indicated on the plan by this dotted line; that is to say, a portion which had, and a portion which had not, been manured with ammonia-salts in 1849. The shaded portions show the patches where the clover-plant had died off.

On the first glance at the Diagram, it is seen that the plots which had not been manured with either farmyard-manure, ammonia-salts, or rape-cake (Series 1), were by far the freest from disease. The next in order in this respect was that half of Series 2 indicated below the dotted line; that is to say, the portion of the dung and lime plots which had not been manured with ammonia-salts in 1849. The other half of the plots of Series 2, namely, the portions which had received ammonia-salts in 1849—the plots of Series 3, which had also received ammonia-salts in 1849—and those of Series 4, which had been manured with rape-cake in that year, all show a very great failure of the plant. It is, however, equally clear, that the Plots 4, 5, and 6 of these Series (with the exception of Plot 6, Series 4) were much less affected than Plots 1, 2, and 3 of the same Series; that is to say,

PLAN OF EXPERIMENTAL CLOVER PLOTS.— APRIL 1852.

The Shaded Portions represent the places where the Plant had died off



although the ammonia-salts and the rape-cake seemed to have provided conditions in the soil very injurious to the healthy development of the Clover, the sulphate of potash, and superphosphate of lime (Plots 4), and the sulphates of potash, soda, and magnesia, both with and without superphosphate of lime (Plots 5 and 6), obviously greatly mitigated the injury, whilst they seem almost to have prevented it, up to the date now in question, where they were used without either ammonia-salts or rape-cake.

In some cases, as will be readily seen from the number and the size of the patches, the produce was considerably reduced by the disease. But there was still, upon the whole, a good plant remaining, and such variety of result in regard to the disease, according to the manure employed, that it was thought quite worth while to continue the experiment. Acordingly, the crop was cut on June 24, fresh manures were applied on June 26, and a second crop was cut August 29. In Table IV. are given the amounts of produce obtained at the first cutting, the description and amount of the manures applied, and the amount of produce at the second cutting.

The produce of the first cutting of the clover, in 1852, is given in the first two columns of the Table (IV.). It will be seen that it is in no case equal in amount to 2 tons of hay per acre. On comparing the amount of crop on the plots of one Series with that on those of another, it is seen that it is generally the highest where only the mineral manures were used, that is, in Series 1. It is the next best in Series 2, where, in addition to mineral manures, dung and lime had been used in 1851. It is less in Series 3, where, with the same mineral manures in 1851, as in Series 1 and 2, ammonia-salts, with or without mineral manures, had been employed in 1849; and it is the worst in Series 4, where rape-cake had been supplied in 1849, and soot, lime, &c., in 1851. The results within each Series, however, show a greater produce where sulphate of potash and superphosphate of lime, the "mixed alkalies," and the "mixed alkalies" and superphosphate of lime together, were employed.

There was then, as before, some benefit arising from the use of mineral manures, especially those which contained *potash* and *phosphoric acid.* And as the object of the experiments was to ascertain whether by liberal manuring, and especially by a supply of the mineral constituents which the Clover crop removes so largely from the soil, it were possible to grow the crop year after year on the same land, an abundant top-dressing of mineral constituents was applied on June 28 (1852), after the removal of the first cutting. The second division of the Table (IV.) shows the description, and amount, of the manures employed; and the third division the amount of crop obtained on August 29.

The

Experiments on the Growth of Red Clover by Different Manures.

Table IV.—Showing the Amount of Produce obtained per Acre in the First Crop, the Description and Amount of Manures Employed, and the Amount of Produce afterwards obtained in the Second Crop.

Third Season, 1852.

Plot, Nos.	Produce per Acre, 1st Cutting, June 24, 1852. Weight Fresh, as Cut. (ton. cwt. qr. lb.)	Produce per Acre, 1st Cutting, June 24, 1852. Weight, calculated as Hay. (ton. cwt. qr. lb.)	MANURES Per Acre, Sown June 26, 1852.	Produce per Acre. 2nd Cutting, August 29, 1852. Weight, Fresh, as Cut. (ton. cwt. qr. lb.)	Produce per Acre. 2nd Cutting, August 29, 1852. Weight, calculated as Hay. (ton. cwt. qr. lb.)	Total Produce per Acre, 1852. 1st and 2nd Cuttings. Weight Fresh, as Cut. (ton. cwt. qr. lb.)	Total Produce per Acre, 1852. 1st and 2nd Cuttings. Weight, calculated as Hay. (ton. cwt. qr. lb.)
			Series 1.—Unmanured, or with Mineral Manures Alone, in 1852, 1851, and 1849.				
1	4 14 2 8	1 3 2 12	Unmanured	2 17 0 27	0 16 3 25	7 11 3 7	2 0 2 9
2	5 3 3 7	1 4 3 18	Superphosphate of Lime (300 lbs. Bone-ash and 225 lbs. Sulphuric Acid, sp. gr. 1·7)	2 15 0 11	0 17 2 8	7 18 3 18	2 2 1 26
3	5 1 0 7	1 4 2 14	500 lbs. Sulphate of Potash	3 3 2 4	0 19 0 10	8 4 2 11	2 3 2 24
4	7 13 0 3	1 16 0 24	500 lbs. Sulphate of Potash, and "Superphosphate of Lime"	3 13 2 16	1 2 2 22	8 6 2 19	2 18 3 18
5	7 3 0 6	1 12 1 14	Mixed Alkalies (500 lbs. Sulphate of Potash, 225 lbs. Sulphate of Soda, and 100 lbs. Sulphate of Magnesia)	3 8 1 27	0 14 3 14	10 11 2 5	2 7 1 0
6	6 13 2 20	1 12 1 17	"Mixed Alkalies," and "Superphosphate of Lime"	3 0 0 6	0 19 1 1	9 13 2 26	2 11 3 0
			Series 2.—Unmanured, or with Mineral Manures Alone, in 1852; with Farmyard Manure and Lime, either Alone or with Mineral Manures in Addition, in 1851; and with Ammonia-Salts Alone, or with Mineral Manures, on Half of each Plot, in 1849.				
1	3 16 0 17	0 18 2 5	Unmanured	2 0 1 13	0 12 3 17	5 16 2 2	1 11 1 22
2	5 3 1 3	0 12 0 0	Superphosphate of Lime (300 lbs. Bone-ash and 225 lbs. Sulphuric Acid, sp. gr. 1·7)	2 1 3 2	0 14 1 22	7 5 0 5	1 6 1 22
3	5 2 3 14	1 4 2 5	500 lbs. Sulphate of Potash	2 9 2 27	0 15 3 25	7 12 2 13	2 0 2 2
4	8 8 2 22	1 19 1 2	500 lbs. Sulphate of Potash, and "Superphosphate of Lime"	3 5 0 23	1 2 1 16	11 13 3 17	3 1 2 18
5	7 5 2 11	1 12 2 27	Mixed Alkalies (500 lbs. Sulphate of Potash, 225 lbs. Sulphate of Soda, and 100 lbs. Sulphate of Magnesia)	2 14 3 16	0 16 3 12	10 0 1 27	2 9 2 11
6	6 19 2 15	1 12 3 6	"Mixed Alkalies," and "Superphosphate of Lime"	3 0 3 27	0 18 3 22	10 0 2 24	2 11 3 0
7	6 12 2 1	1 11 3 2	"Mixed Alkalies," and "Superphosphate of Lime"	1 18 1 27	0 13 1 15	8 11 0 0	2 5 0 17
			Series 3.—Unmanured, or with Mineral Manures Alone, in 1852, and 1851; Ammonia-Salts Alone, or with Mineral Manure, in 1849.				
1	2 13 2 25	0 13 3 22	Unmanured	1 4 1 20	0 7 2 27	3 18 0 17	1 1 2 21
2	3 0 3 15	0 14 3 3	"Superphosphate of Lime"	1 10 3 27	0 11 1 6	4 11 3 14	1 6 0 9
3	3 19 3 25	0 19 2 22	500 lbs. Sulphate of Potash	2 5 0 6	0 13 2 18	6 5 0 3	1 13 1 12
4	6 3 2 22	1 7 2 22	500 lbs. Sulphate of Potash, and "Superphosphate of Lime"	2 10 0 23	0 16 3 9	8 13 3 17	2 4 2 3
5	7 4 1 16	1 12 1 20	"Mixed Alkalies"	2 19 2 9	0 19 3 13	10 3 3 25	2 12 1 5
6	4 11 1 12	1 2 0 9	"Mixed Alkalies," and "Superphosphate of Lime"	1 19 1 20	0 12 2 24	6 10 3 4	1 14 3 5
			Series 4.—With Mineral Manures Alone in 1852; with Soot, Soot and Lime, or Soot, Lime, and Mineral Manures, in 1851; and Rape-Cake in 1849.				
1	3 15 3 26	0 19 0 2	500 lbs. Sulphate of Potash	1 18 0 20	0 12 2 23	5 14 0 18	1 11 2 25
2	2 9 1 26	0 12 2 16	900 lbs. Sulphate of Soda	1 13 0 10	0 12 0 21	4 2 2 8	1 4 3 9
3	3 5 2 6	0 17 0 15	700 lbs. Sulphate of Magnesia	1 13 0 0	0 11 2 4	4 18 2 6	1 8 2 19
4	5 16 1 2	1 8 1 17	500 lbs. Sulphate of Potash, and "Superphosphate of Lime"	2 14 1 20	0 18 0 22	8 10 2 22	2 6 2 11
5	7 1 2 14	1 12 3 17	900 lbs. Sulphate of Soda, and "Superphosphate of Lime"	2 2 2 6	0 15 0 22	9 4 0 20	2 8 0 11
6	3 1 3 6	0 14 3 11	700 lbs. Sulphate of Magnesia, and "Superphosphate of Lime"	1 11 3 20	0 11 0 5	4 13 2 26	1 5 3 16

The produce, after the heavy dressing of mineral manure upon the removal of the first cutting, is seen to be, in every case, small. In only two instances is it equal to more than a ton of hay per acre, namely, on Plot 4, Series 1 and 2; that is, where sulphate of potash and superphosphate of lime were applied. In all the Series, however, the effect of the potash, and of the potash and phosphate together, is more or less marked. In fact, notwithstanding that this was the third season of Clover in four years, the produce with these manures, taking the two cuttings of 1852 together, was, in several cases, equal to from $2\frac{1}{2}$ to 3 tons of hay per acre.

A good deal of the plant stood tolerably well during the winter of 1852-3, but almost all died off in the spring. The land was therefore ploughed up, and fresh Red Clover-seed *drilled* in April, in rows 20 inches apart, in order to admit of the use of the horse-hoe. The plant came up very weak; there was no crop worth cutting in the autumn; and nearly the whole died off during the winter of 1853-4.

In the spring of 1854, the land was again ploughed up, and allowed to remain fallow until September. The whole piece consisted of 15 "lands," each 13 feet 3 inches wide, divided into 6 lengths, forming the 6 "Plots" numbered from 1 to 6 respectively, in the Tables. It was now divided into three widths only, of 5 lands each, represented in subsequent Tables as Series 1, 2, and 3.* One of these (Series 1), the whole length of the 6 plots of course, was left unmanured; the second (Series 2) was manured with 20 tons of farmyard manure down the whole length of the 6 plots; and the third (Series 3), also throughout the 6 plots, was manured with 20 tons of farmyard manure, and 5000 lbs. of freshly burnt lime, per acre. These were ploughed in on September 25, 1854, and Clover-seed was drilled on October 10. Plants just came up, but all died off during the winter of 1854-5.

Clover-seed was again drilled on April 14, 1855, at the rate of 20 lbs. per acre, without further manure. The following Table (V.) shows the manures applied in 1854, and the produce of Clover obtained in September, 1855, without manure since 1854, but after a second and heavy sowing of seed.

* The Plots designated in Tables III. and IV. as Series 1, 2, and 3, consisted of four lands each; and those as Series 4, of three lands, each running the length of the six Plots which had either no mineral manure, or one of the five different descriptions enumerated in the Tables. Under the new arrangement, Series 1 (now to be unmanured) includes the four lands of the former Series 1, which from the beginning were manured with mineral manures only, and one land of the former Series 2, which had the dung and lime applied in 1851; Series 2 (now to be manured with farmyard manure alone) includes the remaining three lands of the former Series 2, and two lands of the former Series 3, which, besides the several dressings of mineral manures, was manured in 1849 with ammonia salts; and Series 3 (now to receive farmyard manure and freshly burnt lime) includes the two remaining lands of the former Series 3, and the three lands of the former Series 4, which latter (besides the mineral manures as specified) were manured with rape-cake in 1849, and with soot, lime, &c. in 1851.

EXPERIMENTS on the GROWTH of RED CLOVER by DIFFERENT MANURES.

TABLE V.—Showing the MANURES applied in 1854, and the PRODUCE of CLOVER, obtained in September, 1855, from Seed sown in April of that year, after the failure of Seed sown in April, 1853, and in October, 1854.

SIXTH SEASON, 1855.

Plot, Nos.	MANURES per Acre. Put on September 25, 1854.	PRODUCE OF CLOVER per Acre, September, 1855. Weight Fresh, as Cut.				Weight calculated as Hay.			
		tons.	cwts.	qrs.	lbs.	tons.	cwts.	qrs.	lbs.
	SERIES 1.								
1	Unmanured	1	7	3	6	0	4	2	14
2		1	14	3	2	0	5	3	4
3		1	13	1	26	0	5	0	18
4		3	11	2	26	0	11	3	21
5		2	16	1	18	0	9	1	15
6		3	18	0	6	0	12	3	26
	SERIES 2.								
1	20 tons Farmyard Manure	4	12	2	2	0	19	3	22
2		3	14	0	4	0	15	3	24
3		3	15	1	2	0	16	0	26
4		5	6	0	8	1	2	3	13
5		5	4	3	16	1	2	2	13
6		5	12	3	2	1	4	1	8
	SERIES 3.								
1	20 tons Farmyard Manure, and 5000 lbs. fresh-burnt Lime	4	1	3	6	1	0	0	16
2		2	17	2	10	0	14	0	20
3		3	6	2	4	0	16	1	15
4		3	12	3	12	0	17	3	21
5		4	3	2	2	1	0	2	7
6		3	5	0	22	0	16	0	6

The figures in the Table show that the produce in this sixth season of the attempt to grow Clover continuously on the same land, and after two years of entire failure, was in every case small. Comparing Series with Series, the crop is the best where the farmyard manure alone was employed; the next best, where the Farmyard manure and Lime were used; and it was the worst where no manure was now employed, and where, for the most part, mineral manures alone had previously been employed. Still, comparing the results within each Series, there is again evidence of some increase on those plots which had formerly received manures containing *potash*, and *phosphoric acid*.

The plant of 1855 died off in the succeeding winter. The land was ploughed up and allowed to remain fallow during 1856 and 1857.

In the spring of 1858, it was decided to take a crop of Barley, without manure, before making any further attempt to grow Clover. It was, however, not thought worth while to determine the produce of Barley on each of the many differently manured Clover-plots separately. Accordingly, only the main divisions, represented by the Series 1, 2, and 3, of 1854 and 1855, were adopted. The produce of Barley, per acre, over each of these three portions of land, is shown in Table VI.

EXPERIMENTS on the GROWTH of RED CLOVER by DIFFERENT MANURES.

TABLE VI.—Showing the MANURES applied for CLOVER in 1854, and the PRODUCE of BARLEY in 1858, after the removal of a small Crop of Clover in 1855 (the Sixth Season), and a Fallow in 1856 and 1857.

Plot, Nos.	MANURES Per Acre, for Clover, in 1854.	PRODUCE OF BARLEY per Acre, &c., in 1858.					
		Dressed Corn.		Weight per Bushel of Dressed Corn.	Total Corn.	Total Straw, &c.	Total Produce. (Corn and Straw).
	Series 1.						
		bush.	pks.	lbs.	lbs.	lbs.	lbs.
1 2 3 4 5 6	Unmanured	58	0	52·0	3181	3417	6598
	Series 2.						
1 2 3 4 5 6	20 tons Farmyard Manure ..	65	2	52·0	3562	4016	7578
	Series 3.						
1 2 3 4 5 6	20 tons Farmyard Manure, and 5000 lbs. fresh-burnt Lime	64	0	52·5	3486	3738	7224

It is obvious, that although the land was incapable of yielding a crop of Red Clover, it embraced all the conditions requisite for the production of a very luxuriant crop of Barley. The lowest produce, that on the plots of Series 1, of this "clover-sick" land, was 7¼ quarters of Barley per acre, of 52 lbs. weight per bushel. The highest produce, that on the plots of Series 2, where the

Farmyard manure alone had been applied in 1854, was about $8\frac{1}{4}$ quarters; and that where the Farmyard manure and Lime were used together (in 1854), was just 8 quarters of Barley, weighing $52\frac{1}{2}$ lbs. per bushel.

After growing this luxuriant crop of Barley, one more attempt to grow Clover was made, but without any further manuring. In the spring of 1859, Clover-seed was sown, without a corn crop; but by a mistake of the seedsman, Cow-grass, instead of Red Clover, was sent, and the error was only discovered when it was too late for correction. The crop was cut in September. The amount of produce on each plot is recorded in Table VII. which now follows:—

EXPERIMENTS on the GROWTH of CLOVER by DIFFERENT MANURES.

TABLE VII.—Showing the MANURES applied for CLOVER in 1854, and the PRODUCE of CLOVER in 1859, after the removal of a small Crop of Clover in 1855 (the Sixth Season), Fallow in 1856 and 1857, and after removing a Crop of Barley in 1858.

Plot, Nos.	MANURES Per Acre, for Clover, in 1854.	PRODUCE OF CLOVER per Acre, September, 1859. Weight Fresh, as Cut.				Weight calculated as Hay.			
		tons.	cwts.	qrs.	lbs.	tons.	cwts.	qrs.	lbs.
	SERIES 1.								
1	Unmanured	2	9	1	22	0	17	1	18
2		3	5	2	8	1	0	3	11
3		3	1	3	8	1	1	0	11
4		3	10	3	8	1	2	3	8
5		3	12	2	22	1	3	2	3
6		4	4	1	8	1	7	1	14
	SERIES 2.								
1	20 tons Farmyard Manure	3	13	3	8	1	3	1	7
2		4	2	1	22	1	4	1	19
3		4	11	1	22	1	7	0	10
4		4	5	1	22	1	6	1	1
5		4	11	3	8	1	8	3	1
6		4	6	2	8	1	7	2	24
	SERIES 3.								
1	20 tons Farmyard Manure, and 5000 lbs. freshly-burnt Lime	4	13	2	22	1	7	3	16
2		4	10	1	8	1	5	3	2
3		4	15	0	22	1	7	1	10
4		5	5	1	8	1	8	2	13
5		5	0	3	8	1	9	0	12
6		5	4	3	4	1	10	3	6

As in the case of the last crop of Clover, that of 1855, the year after the heavy dressing of Farmyard manure on one-third, and of Farmyard manure and Lime on another third of the experimental land, the so-manured portions, again, in 1859, yield a somewhat larger crop than the corresponding plots of Series 1, which had no such application. The plots of each Series, however, yield somewhat more produce in 1859, than they did in 1855. The crops are, however, in all cases, insignificant, being generally equal to not much more than 1 ton of hay per acre; but there is still slight indication of improvement where the mineral manures containing potash, or potash and phosphoric acid, had been liberally employed in the earlier years of the experiment.

The plant continued to look tolerably well throughout a good part of the winter (1859-60), but as the spring advanced it died off rapidly, and, at the time we write, the end of June, the small proportion of the original plants that still survive have a very stunted and unhealthy appearance.

From the numerous results which have been recorded, in the foregoing pages, of experiments in which Clover has been submitted to a very great variety of manurial, and other conditions of growth, it is evident that no direct supply of manure, in the ordinary form of farmyard dung, or of the current artificial manures, is capable of restoring the soil from which a heavy crop of Clover has been taken, to a condition of immediate productiveness for the same crop. In the experiments in question, not even the most complex conditions, and the repeated supply of those constituents which are found most to increase the Clover-crop when it is grown in the usual manner, after an interval of several years, have restored the Clover-yielding capabilities which the soil possessed at the commencement of the experiment, in 1849.

Before entering upon any consideration of the probable causes of the failure of the Clover in the experiments which have been already described, it will be well to give the results of some experiments conducted on a small scale in the kitchen-garden at Rothamsted. The soil was in ordinary garden cultivation, and has probably been so for two or three centuries. Early in 1854, $\frac{1}{500}$ of an acre (about $9\frac{3}{4}$ square yards) was measured off and sown with Red Clover, on March 29. From that time to the end of 1859, fourteen cuttings have been taken, without any re-sowing of seed. In 1856, this little plot was divided into three equal portions. Of these, No. 1 has been kept continuously without manure; No. 2 was manured with gypsum; and No. 3 with sulphates of potash, soda, and magnesia, and superphosphate of lime. Table VIII. shows the amount of produce obtained, both green, as cut, and calculated as hay, per acre; but as the space

allotted to each experiment was so extremely small, the results must by no means be taken as absolutely correct. They can, indeed, be only looked upon as rough approximations; but, as such, they may be trusted as indicating the large amount of produce of Clover that has been taken from this garden soil, and as affording some idea of the relative amount of produce under the three different conditions of manuring.

The estimated total amount of green Clover obtained in six years from this garden soil, without further manure, is nearly 126 tons per acre—equal to about 26½ tons of hay, or to an average of nearly 4½ tons of Clover-hay, per acre, per annum. The produce was considerably increased by the application of gypsum, and still more so by that of the sulphates of potash, soda, and magnesia, and superphosphate of lime. In four years, the increase by the use of gypsum amounted to about 15½ tons of green Clover, or about 3½ tons of hay—nearly 1 ton of hay per acre per annum. The increase in the four years, by the use of the alkalies and phosphate, is estimated to amount to 28¾ tons of green produce, or rather more than 6½ tons of hay—equal to nearly 1¾ tons increase of hay per acre per annum.

It is worthy of remark, that it was in some of the very same seasons in which these heavy crops of Clover were obtained from the garden-soil, even though grown year after year, and without fresh seed, that we entirely failed to get anything like a moderate crop of Clover in the experimental field, only a few hundred yards distant. The failure in the latter case would, therefore, appear to be connected with the conditions of *soil* in relation to the plant, rather than to those of the *atmosphere.*

We now come to another and not very satisfactory part of our task; namely, that of endeavouring to seek, among the various causes of Clover-failure which have been suggested, for some explanation of the signal failure of the crop in our experimental field.

The comparison of the results in the garden with those in the field, seems to lead to the exclusion of some of the reasons enumerated in the early part of our Paper, as having been brought forward to account for the Clover failure. It may be well, however, to make a few passing remarks on some of them.

With regard to the *attacks of Insects:*—Those who have examined the plants on a field of Clover failing in the ordinary way, will probably sometimes have found a small insect in those plants which are beginning to show signs of dying off. It is generally found near the junction of the root and crown. Now, as experience teaches us that the plant seldom suffers serious injury if a sufficient number of years has elapsed since Clover was grown before,

TABLE VIII.—Showing the *estimated* PRODUCE per ACRE, of CLOVER grown 6 Years consecutively on the same Plots of Garden Soil, from One Sowing of Seed only.

	ESTIMATED PRODUCE PER ACRE.																							
	WEIGHED GREEN.												CALCULATED AS HAY.											
	Unmanured.				With Gypsum, applied May 22, 1856.				With Sulphates of Potash, Soda, and Magnesia, applied May 22, 1856.				Unmanured.				With Gypsum, applied May 22, 1856.				With Sulphates of Potash, Soda, and Magnesia, applied May 22, 1856.			
	tons.	cwts.	qrs.	lbs.	tons.	cwts.	qrs.	lbs.	tons.	cwts.	qrs.	lbs.	tons.	cwts.	qrs.	lbs.	tons.	cwts.	qrs.	lbs.	tons.	cwts.	qrs.	lbs.
1854—2 Cuttings	10	18	3	0	..		..		..		..		2	7	2	24	..		..		..		..	
1855—3 Cuttings	39	10	0	20	..		..		..		..		8	1	2	24	..		..		..		..	
1856—2 Cuttings	23	5	1	17	25	8	3	20	29	5	3	21	4	6	2	10	4	19	1	25	5	12	1	6
1857—3 Cuttings	27	10	3	3	30	16	3	18	33	2	0	12	6	2	0	14	6	14	1	10	7	6	0	25
1858—2 Cuttings	14	1	1	0	19	18	1	21	24	5	1	27	3	1	1	19	4	5	3	15	5	5	1	8
1859—2 Cuttings	10	17	2	15	14	19	2	18	17	18	1	1	2	7	2	0	3	7	0	1	4	6	0	7
Total Produce, 6 years ..	125	13	3	27	..		..		..		..		26	7	0	7	..		..		..		..	
Average Annual Produce, 6 years	20	19	0	0	..		..		..		..		4	7	3	10	..		..		..		..	
Total Produce, last 4 years	75	15	0	7	91	3	3	21	104	11	3	5	15	17	2	15	19	6	2	23	22	9	3	8
Average Annual Produce, last 4 years	18	18	3	2	22	15	3	26	26	2	3	22	3	19	1	18	4	16	2	20	5	12	1	25
Total Increase by Manure, last 4 years	..		..		15	8	3	14	28	16	2	26	..		..		3	9	0	8	6	12	1	3

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before, it would appear that the prevalence of the insect, and its consequent injury to the plant, is the result, rather than the original cause, of the diseased condition. In fact, it is probable that the success of the attack of the insect upon the plant, may be mainly due to the weak or unhealthy condition of growth of the latter; and that, had the plant been perfectly vigorous, the insect would not be so freely developed, or its injury would at least be more successfully resisted.

Excrementitious Matters.—There is evidence of various kinds to show that plants give out certain substances by their roots to the soil. It is not probable, however, that any mineral constituents which may be so rejected during the growth of one Clover-crop, are prejudicial to the growth of a similar crop on the same land for a number of years to come. If the failure of the Clover-plant, when repeated too soon upon the same land, be due at all to the excrementitious matters left by the former crop, it is much more probable that the injury is in some way connected with the organic matters which have been rejected. Unfortunately, we are not yet able, by the aid of chemistry, to distinguish those organic compounds of the soil which are convertible into the substance of the growing plant, and those which are not so. Nor do we know how far the excreted organic matters may be necessary complimentary products in the formation of some of the essential constituents of the plant. Experience teaches us that when a crop of Clover is eaten by sheep folded upon the land, animals dislike the growth which immediately succeeds. It might be inferred, therefore, that, in such a case, the plant had taken up from the soil, certain matters which it had not finally elaborated. Whether these organic substances would, in process of time, be converted into living plant-matter, or whether they would wholly, or in part, be rejected as excrementitious organic compounds, to undergo in the soil certain chemical changes before being adapted for plant-food, we are not able to determine.

In connexion with this question, of whether or not the failure of the Clover-crop be due to the injurious influence of excrementitious organic matters, left by the last crop of the same kind, attention may be called to the fact, that in the case of the failure in our field experiments, two years of fallow, and one year of barley, intervened between the poor crop of Clover in 1855, and the almost equally poor one in 1859. *A priori*, we should certainly be disposed to think, that any deleterious matters left in the soil by the Clover-crop of 1855 would, under the circumstances in question, have undergone pretty complete decomposition during the three succeeding years. At the same time, it should be remembered that, in 1852, the plant of Clover suffered very much

more where Rape-cake, or Salts of Ammonia had been applied in 1849, than where mineral manures only had been employed.

Exhaustion of the Soil.—Some of the plots in the experimental Clover-field have doubtless been subjected to great exhaustion of certain constituents, by the removal of the whole of the produce, without adequate restoration by manure. On others, however, there has been considerable accumulation of constituents. Calculation shows, indeed, that, on many of the plots, there have been much larger quantities of every "mineral" constituent supplied in the manures, than have been removed in the total produce, during the entire period of the experiments. Of certain organic constituents, however, including nitrogen, more has been taken off in the crops than has been supplied in the manures. But if, in the cases in question, the produce grown without manure, be deducted from that grown with it, it then appears, that the manures have provided very much more, not only of the mineral constituents, but of nitrogen also, than was contained in the increase due to the manures. It cannot be supposed, therefore, that, in the instances here referred to, any of the ultimate elements of the crop could be wanting.

It should be remembered, too, that in some of the experiments mineral manures alone were employed, in others mineral manures and ammonia salts, and in others large quantities of farmyard dung, mineral manures, and ammonia salts, and so on; so that the proportions, and conditions of combination, in which the different constituents were supplied, were very variable.

How then are we to account for the fact, that whilst, under the conditions described, the Clover-plant would not grow healthily in the experimental field, we have been able to cut fourteen crops from seed sown six years ago in a garden only a few hundred yards distant? Are we to suppose, simply, that the ultimate constituents required by the Clover, were more abundantly available to the plant in the garden soil? or is it that they there existed in different states of combination? It will not be out of place to make a few observations bearing upon the latter supposition.

According to Mulder, who has investigated the organic compounds of the soil, the vegetable matters, rich in carbon, decomposing in the soil, go through a gradationary series of changes before being finally converted into carbonic acid. He supposes the intermediate compounds to constitute a series of acids, which combine with ammonia, and with fixed bases, in the soil, forming so many organic-acid salts. Now, if we were to suppose that some plants (Clover for example) required for healthy growth a certain proportion of their food to be presented to them in the form of such carbon-compounds, more complex than carbonic acid, and perhaps combined with ammonia, we should then the

more easily comprehend why it should be necessary for a certain period of time to intervene before again cultivating certain crops on the same land ; for, we could easily understand that this might be requisite for the gradual formation and accumulation of a sufficient amount of the compounds in question.

Whatever may be the precise chemical character of the carbon compounds of the soil, more complex than carbonic acid, there are numerous facts in horticulture, and even in agriculture, leading to the supposition that some plants take up a part at least of their carbon from some other form of combination than carbonic acid.

In one of our experimental fields we have grown very large crops of wheat for 17 consecutive years, without the supply, by manure, of a single ounce of carbon. The crops have been considerably greater on some plots where no carbon has been supplied in the manure, than on others to which it had been very largely supplied. There are, indeed, good reasons for supposing that carbonic acid is, at any rate, the chief, if not the exclusive source, of the carbon of many of the plants yielding food largely to man and other animals—which, by their respiration, return so much carbonic acid to the atmosphere. Were it not so, as forests make way for the growth of food, the proportion of carbonic acid in the atmosphere would gradually increase. The cultivation of the cereal crops, which enter so largely into the food of man and other animals, seems admirably adapted for preserving the equilibrium in the composition of the atmosphere ; for an acre of wheat will decompose as much, or more, carbonic acid, liberating a corresponding amount of oxygen, as an acre of the forest which it may have supplanted.

Provided the soil yield a sufficient supply of the necessary mineral constituents, the amount of carbonic acid decomposed by a cereal crop over a given area, will very much depend upon the amount of nitrogen, in an available condition of combination, and distribution, within the soil. But the direct supply of nitrogen to the soil in the form of ammonia, which so much increases the vigour of growth of Graminaceous crops generally, and consequently the amount of carbon which the plants will assimilate from carbonic acid, so far from effecting the same result in the case of Leguminous crops, is generally injurious to them.

In the early years of our experiments, both upon Clover and upon Beans, the application of the fixed alkalies as manure, and especially of potash, caused a considerably increased assimilation of both carbon and nitrogen over a given area ; whilst the direct use of ammonia-salts, which are so efficacious in the case of our Graminaceous crops, had either little or no such effect, or was more frequently injurious, in the case of these Leguminous crops. Where the supply of mineral constituents is sufficiently kept up, the supply of ammonia is as efficient as ever in enabling the wheat

growing in the experimental field to assimilate an increased amount of carbon from carbonic acid. The alkalies, potash, &c., have ceased to be as useful as manures for the Leguminous crops, as they were at the commencement of the experimental period; yet, so far as the atmosphere is a source of constituents to these plants, its supplies must be the same now as formerly. The decline in the beneficial influence of the potash, &c., would appear, therefore, to be connected with some defective condition within the soil.

If we were to assume that the Leguminous plants required a certain portion of their organic food to be supplied to them in the form of certain organic compounds in the soil, it is evident that the beneficial action of the potash, &c., would cease when these organic compounds were exhausted. On this assumption, too, it would seem intelligible, on the one hand, that an ordinary soil should require a considerable period of time after the growth of a Leguminous crop, to become again fertile for the same crop, and—on the other, that a garden soil, liberally manured with organic matter, perhaps for centuries, should support a considerable number of such crops in succession.

It is further worthy of remark, in connexion with the beneficial action of the alkalies as manures for Leguminous crops, and with the supposition that these crops may require a portion of their organic food in the form of certain carbon compounds which are more complex than carbonic acid, that it is chiefly by the aid of the alkalies that the organic compounds of the soil are rendered soluble. On recently cleared lands in America, where there is such a great accumulation of vegetable remains, the employment of ashes, and of gypsum, as top-dressings for Clover, has been attended with remarkable success. Vegetable ashes have been found to be beneficial to the crop in this country also, which, independently of the mere *supply* of potash, &c., may be partly due to the action above referred to. Gypsum, however, is by no means to be depended upon as a manure for Clover in this country. The action of gypsum has been very variously explained upon high authority. The following distinct explanations are on record, namely:—that it serves as a supply of sulphuric acid—that it serves as a supply of lime—that it serves as a supply of sulphur—and that it serves for the fixation of ammonia. It is perhaps not less likely that its beneficial action may be connected with changes in the organic matters of the soil. M. Risler has indeed shown, that an aqueous solution of gypsum will take up more organic matter from soil, than will water.

We are far from asserting that there is evidence enough to show that the failure of Clover, when grown too frequently on the same land, is altogether due to the want of a sufficient supply of certain organic compounds in the soil. At the same time, we think that the facts of horticultural and agricultural practice, as

well as the evidence of direct experiment, must lead to the conclusion, that the view—that the organic compounds of the soil are only valuable to plants as a source of carbonic acid—requires modification. It is, indeed, probable, that some plants derive a considerable amount of their substance from carbon compounds other than carbonic acid, and that others depend for their carbon mainly, if not exclusively, upon carbonic acid.

Those of our crops which, in the course of cultivation, are subjected to pretty natural conditions of growth, and which accumulate the greater portion of their substance during the period at which the sun's rays are known to be most powerful in influencing the decomposition of carbonic acid by plants, appear to depend chiefly on that source for their carbon. Those, on the other hand, which are grown under somewhat abnormal conditions, and which store up a large amount of succulent products of a comparatively low degree of elaboration, are probably partly dependent on other carbon compounds, yielded by the soil. The Leguminous crops, again, though generally coming more within the former than the latter category, still seem to be dependent, for luxuriant growth, more or less upon a supply, within the soil, of complex organic compounds.

But whatever may be the precise result to which investigation may lead, in regard to the questions here involved, it may, at any rate, be pretty safely affirmed, that we shall not arrive at the true explanation of the phenomena upon which depend some of the most striking advantages of a rotation of crops, until we are better able than at present, to define the relations of the different crops to the different sources of *carbon*, and of *nitrogen*.

The practical conclusions from the inquiry may be very briefly stated:—

When land is not what is called "clover-sick," the crop of Clover may frequently be increased by top-dressings of manure containing potash, and superphosphate of lime; but the high price of salts of potash, and the uncertainty of the action of manures upon the crop, render the application of artificial manures for Clover a practice of doubtful economy.

When land is what is called "clover-sick," none of the ordinary manures, whether "artificial," or natural, can be relied upon to secure a crop.

So far as our present knowledge goes, the only means of insuring a good crop of Red Clover is to allow some years to elapse before repeating the crop upon the same land.

XII.—*On the Moveable Steam-Engine.*

By P. H. Frere.

These notes on the moveable steam-engine are designed for the information of farmers who reside in those parts of England where it is not yet naturalized; where, consequently, the prices charged for work done have not yet been properly adjusted, or the cost and liabilities incurred for repairs and renovation adequately determined. Such readers may gather useful hints from details which to others may appear commonplace. They must bear in mind, however, that the experience recorded has been drawn from a neighbourhood where the yield of grain is large in proportion to the bulk of the straw grown; where the land is chiefly arable, and, therefore, much employment is provided for the machine in a small circuit; where the farms, also, are large, so that the work goes on consecutively for several days without the delay and waste of time caused by removal; and where the occupation-roads, though not good, are passable. Each reader must, therefore, decide for himself what allowance he must make in applying the conclusions arrived at to his own neighbourhood.

In the eastern counties the hired steam-engine is now in such general use that competition has done its work; prices have found their level, and the same profits cannot be made as rewarded the enterprising men who first set them going, or even the owner of the solitary horse-power machine of the district, in times gone by. Where the engine and machine have been purchased with judgment, a good model and sound workmanship have given a fair profit; but several men, possessed of small capital and little knowledge, have lost money by the speculation, by their want of discretion. To show how loss is incurred, I may state that I bought a machine for 105*l.*, worked it for 3 months, found that it was not up to the mark, laid it by for a time, and then returned it to the maker, who gave me 10*l.* for it. Bad debts, too, will arise; I have had one of about 50*l.*

As regards the amount of work done, 40 quarters of grain may be considered an average yield from one day's wheat-threshing from sheaves chiefly mown. This will increase in a good year up to 45 quarters from mown wheat, and 55 quarters from reaped corn. We once threshed in a day of 10 hours, at Michaelmas, 75 quarters of wheat. For barley, a yield of 35 quarters is reckoned a fair day, and 40 quarters a good day for say 8½ hours' work in autumn and winter. 52½ quarters is our maximum: they were threshed in March.

The regular price of the district was 1*s.* per quarter for wheat

and barley, or 35*s.* a day for the hire of engine and machine, with engineman and feeder; but the price per day has given way to 32*s.*, unless elevators are furnished, when the old charge of 35*s.* is maintained. These elevators dispense with the services of 2 men (or 3 when the straw-stack is high), and are, therefore, well worth the extra charge of 3*s.* Reaped wheat, without the use of elevators, would now be threshed at about 10*d.* a quarter. Oats are not much grown in my district: they are charged at the same rate as other corn, or threshed by the day. We sometimes undertake to furnish extra labour, besides the engineman and feeder, at the charge of 1*s.* 6*d.* per quarter. In this case, the work is thus distributed: the engine-owner finds, besides the use of the elevators,

2 hands for corn-stack.
1 lad to cut bands for feeder.
1 man to tend sacks and clear away cavings.

The hirer will still provide labour

For supply of water and coals.
For loading carts with corn and driving away.
For stacking straw.
For removing cavings, colder, or short stuff.

This arrangement sometimes suits holders of small occupations; but, to the machine-owner, a short job, even at a higher rate of pay, is not so remunerative as a good bout of threshing on a large farm. It will be observed that these calculations are made for threshing in the field, such being our general practice, based on the following reasons.

In the case of wheat, we now set little store by the chaff, and can always easily preserve as large a portion of it as we care to mix with cut straw for the cart-horses; unless, therefore, we cart straight from the field into the barn, for early threshing on a wet day in harvest, the wheat is mostly threshed where it is stacked in the field, to save double handling of the sheaves.

The labour of the yardman and odd horse at odd times, in taking the litter home to the yard, is but little increased in consequence of threshing in the field, and that increase is but little felt. The loss occasioned by the dropping of the stray ears and locks of corn, from the loads when in progress from the stack to the barn, is fully equivalent to the waste arising from grain shed round the threshing-machine, where a small measure of grain would, if scattered, make a great show.

Some old harvest-waggons, which the hilly nature of the farm compels me to retain in use, are very serviceable for receiving and conveying home the cavings or short stuff derived from the barley for the use of the stock, nor are they to be despised as

moveable straw-stands when the wheat-straw requires stacking. The late incendiary fires have unhappily deterred many neighbourhoods from concentrating their stacks around the homestead, according to the old practice.

The common consumption of coals is at the rate of 6 cwt. per day when barley is threshed, or 7 cwt. for wheat. The coals are furnished by the hirer, and their consumption will be a good deal modified by the kind of water with which he supplies the engine; with good soft clean water, drawn from a tank filled from a slated barn, less coal will be burnt by 1 cwt. or 1½ cwt. a day than when the water comes from a dirty pond. It is a happy circumstance for the owner of the engine that the hirer has such an inducement to supply clean water, as the injury done to the engine and boiler (the tubes of which become furred up and foul whenever dirty water is used) is a matter of far more importance than the saving of 1 cwt. or 2 cwt. of coal.

For some years we have never used a flail. The prejudice in favour of fresh flail-threshed straw from the barn-door, for fodder, lingered on in my bailiff's mind for some seasons after I had begun to employ steam-power. Chance removed it in this way. We generally arrange to use the white land barley-straw for fodder, and that grown on heath land for litter. One year the fodder ran short, and we had recourse to some heath barley-straw, which had been machined and stacked some time before, to eke out our supply for food. The stock were observed to eat this straw with more relish than any of the growth of that year. From that time the flail was doomed. The preference shown was accounted for in this manner:—1st, all the dust had been well beaten, shaken, and blown out of the straw by the machine; and, 2nd, the straw, which contained some admixture of layer, had been bruised in threshing, and appeared to have undergone a second gentle heating after it was stacked, and to have benefited by it; but, be the explanation what it may, we were satisfied of the fact, and have since acted on our conviction.

My machines only winnow the corn once; a single dressing then fits it for market. The advantage of a light machine for draught on hilly ground and indifferent farm-roads, and the difficulty of dressing at once, so as just to suit the market, have determined me, after some hesitation, to abide by the older and simpler form, in preference to the new double-dresser.

A connexion with steam-power let out on hire is conducive to the well-being of a farm in several ways:—1st, as an encouragement to steady and intelligent labourers; these are selected from the farm at first to feed the machine, and are then promoted to the charge of the engine; an opening for advancement is thus afforded to a class which stands much in need of such a stimu-

lus.* 2ndly, the work of threshing is most continuous during those months in which other labour is rather slack; it decreases as the spring advances, and labourers become more in request, nor are the machines again called actively into play until the wheat is reaped, and the greater part of it stacked. Some additional hands are therefore made available for the farm connected with the engine, at the time when labourers are most wanted. Again, the occupier of land is able to superintend the working of a steam-engine to greater economical advantage than a man of another class, for he is near at hand, with a horse at command, and an occasional hour to spare for inspecting the work; moreover, he can, without inconvenience, accommodate a small farmer with extra hands, if required, and easily lend one or two horses on an emergency, and when roads are bad and fields wet, to assist in removing the machine and engine—a task which generally devolves on the next hirer.

I shall conclude my statement with a brief abstract of expenses for repairs and other outgoings; 1st, for one engine and machine, in the year ending Michaelmas, 1856, and then for two in 1857, 1858, and 1859. In each case they were in pretty constant employ from September to Lady-day, and had nearly half work between Lady-day and harvest.

Expenses of Steam-Engine and Threshing Machine.

Expenses on one Machine from Michaelmas, 1855, to Michaelmas, 1856.

	£.	s.	d.
Bills	33	14	6
Wages..	52	2	7
Labour, largess, &c.	10	19	7
	96	16	8

1856—1857.

	£.	s.	d.
Repairs	53	15	6
Oil	12	12	0
Insurance	2	1	11
Paid for hire of engine, largess, &c. ..	10	19	8
Wages..	62	17	2
	£142	6	3

A second machine and engine were at work during part of this year.

* To men of this class, wages of 2*s.* 6*d.* instead of 1*s.* 6*d.* a day, with some extras, are a considerable direct gain apart from contingencies. It is the interest of the engineman to put the feeder into the way of managing the engine, for which he gets several little services done in return, so that a succession of engine-drivers possessed of competent knowledge is readily provided if necessary.

1857—1858 (Two Machines).

				£.	s.	d.
Wages				81	8	10
Expenses				10	3	2
Hire of engine				5	2	0
Repairs—	£.	s.	d.			
Carpenter	3	0	0			
Messrs. Ransome	4	1	2			
Blacksmith	17	7	4			
Clayton and Co.	16	11	0			
Hurrell (foundry)	3	5	0			
Parker (straps)	13	6	0			
				57	10	6
				£154	4	6

1858—1859 (Two Machines).

				£.	s.	d.
Wages				87	17	1
Expenses—	£.	s.	d.			
Lodgings, largess, &c.	2	7	6			
Parcels	0	14	0			
Carriage of engines	7	6	6			
				10	8	0
Brasses repaired with patent metal				2	16	2
Cloths				2	16	0
Insurance for one machine and engine				2	2	0
Clayton, bill for oil, brasses, and brushes				29	17	0
Extra oil bill				4	10	0
Hurrell, for casting files, brasses, &c.				7	12	9
Parker (straps)				18	2	0
Mending straps				2	8	0
Ransome and Co., repairs, tarpaulins, &c.				14	5	3
Carpenter				9	10	3
Blacksmith				16	14	0
				£208	18	3

In addition to this expenditure, 10 per cent. on the prime cost was included in each year's account for depreciation, without, however, the residue being regarded as realised profit.

The calculation of 10 per cent. was adopted as the usual allowance made on machinery; but, as Mr. Wells has well shown in his paper on Steam Cultivation,* the agricultural locomotive engine is exposed to an unusual amount of wear and tear.

1st. From the horizontal position of the piston, "which, without great care, rapidly becomes oval-shaped."

2ndly. From the concentrated form of the boiler, the tubes of which are difficult to clean, and wear rapidly away.

3rdly. From the injurious effect of bad roads during removals, and the constant oscillation of the engine when at work.

* A Lecture delivered to the Farmers' Central Club, June, 1860, by Mr. J. Wells, of Booth Ferry House, Howden.

4thly. (We may add) From the evil effects of exposure to dust and wet.

Mr. Wells concludes that the wear and tear of a locomotive must be estimated at fully 20 per cent. above that of a fixed engine. Considering, however, the large items already inserted in these annual accounts for repairs of tubes, boilers, &c., for the engines, and considering, on the other hand, how improvement is constantly superseding older threshing-machines, it appears to me safe to estimate the depreciation both of engine and machine at 20 per cent.

XIII.—*Remarks on the Composition of the Blood, and principally with Reference to those Diseases of Cattle and Sheep in which the Fluid undergoes important Pathological Changes.* By James Beart Simonds, Professor of Cattle Pathology at the Royal Veterinary College, Veterinary Inspector to the Royal Agricultural Society, &c.

In a lecture on the structure and diseases of the organs of respiration and circulation, published in the Society's 'Journal,' Vol. X., page 570, *et seq.*, some observations were made by me on the component parts of the blood, several of which it will be necessary to repeat here, with a few additions, for the sake of unity and completeness. In the present paper, however, it will be my aim to avoid as much as possible entering on disputed points of the physiology of the fluid and of the several assigned causes of the changes it undergoes under ordinary circumstances both within and without the vessels. To attempt this would draw me from the practical object I have in view, and perhaps render the paper less attractive to the majority of the readers of the Journal.

The slightest reflection on the organization of an animal body will suffice to show that it is composed of solid and fluid parts. It is not, however, so well known that the circulating fluids compose no less than a third part of the weight of the individual animal, and that all the so-called solid parts of the frame were at one time in a state of fluidity. The fluids met with are various, consisting chiefly of the blood, the lymph, the chyle, and other secretions. The latter named, as well as the lymph, depend immediately on the blood itself for their existence, while this, in its turn, has its chief source in the chyle—the fluid which is produced in the animal organism by the processes of digestion and assimilation of the food on which the creature subsists. The several changes which the food undergoes before it becomes con-

verted into chyle have been fully set forth in the lecture before referred to, and this being the case it will be only necessary to direct the reader's attention to the explanations therein given.

In comparing the quantity of blood with the entire weight of an animal, it will be found difficult to arrive at the exact proportion they relatively hold to each other, but it is sufficient for our present purpose to state that the amount of blood is usually estimated at from one-fourth to one-fifth of the entire weight of the body.

If we were to attempt to give a popular definition of the blood, it might be described as a fluid which circulates through the heart, arteries, and veins, carrying with it the materials which are indispensably necessary for the maintenance of life, heat, nutrition, renovation, and secretion, building up the organism of the young animal and supporting that of the adult and aged. To effect the passage of the blood from one part of the system to another, various organs are employed and several forces brought into operation. The chief organ for this purpose is the heart, which may be regarded as a central pump, having in connexion with it two sets of vessels—the arteries and veins: the former of these being transmitting, and the latter returning conduits. Besides these vessels there are intermediately placed between them, as it were, another set, called, from their small size, capillaries, to which we shall have occasion, hereafter, more particularly to allude.

It is well known that in all the higher orders of vertebrate animals the blood, as it appears to the unassisted vision, when drawn from its vessels, is red in colour. This redness, however, does not depend on any inherent colour in the fluid itself, but is due to an innumerable number of red corpuscles or cells which are floating within it. If, then, these bodies are removed from the blood, the true *liquor sanguinis* which remains behind will be found to be of a pale straw colour, resembling in this respect the blood of the invertebrate class of animals.

It can be readily imagined that a fluid, which nature employs for such multitudinous purposes in the animal economy, is likely to be very complex in its elements, and such indeed is the case. To analyze these, even imperfectly, it is necessary, as a general rule, that the blood be first removed from its vessels. On this being done, it will be found shortly afterwards that a remarkable change takes place in it, and that it is now no longer fluid but has assumed a solid form. This phenomenon is among the most interesting which belong to the blood, and clearly indicates that the fluid possesses an inherent capability of conversion into organic structure. From the time of Hunter down to the present period, the correct explanation of the phenomenon of coagulation—clotting—has occupied the attention of our ablest chemists and

physiologists; and perhaps it is not too much to say that, notwithstanding all the light which has been shed upon it, some darkness still enshrouds the solution of the problem.

The time which elapses before the blood becomes solid will vary considerably, depending on many adventitious circumstances. The coagulation is usually effected in ten or fifteen minutes, but in some instances many hours and even days will pass before it is completed. Before alluding more particularly to either the clotting of the blood or the variations in the time required for its accomplishment, it will be necessary to describe the principal component parts of the fluid.

On setting aside the coagulated mass and keeping it at rest for a short period, a transparent fluid is found to exude from it, which can easily be decanted off. This is the serum, or so-called watery part of the blood.

THE SERUM.—Under all ordinary circumstances this constituent of the blood remains in a fluid condition, while the quantity which is exuded will be in proportion to the time the coagulum remains at rest, until the expiration of about thirty hours; after which, however, but little more will be expelled naturally, although a still greater amount can be obtained by drying the clot. It is therefore evident that by the act of coagulation the serum is mechanically enclosed in the solidified mass, and that subsequently, by this undergoing a certain degree of condensation, the greater part of it is squeezed out as water is expelled from a sponge by the application of pressure.

Thus obtained, the serum is found to be a viscid fluid of a yellowish colour and having an alkaline reaction. Its specific gravity varies from about 1·025 to 1·050. It is a very important element of the blood, containing not only the watery and saline materials of that fluid, but also the albuminous matters in a state of free solution. In short, it may be said to include the principal portion of all the constituents of the blood with the exception of the fibrine, the hœmatine, and the globuline. The proportion which its several parts bear to each other will materially depend on certain conditional circumstances, such as the kind of food on which an animal is fed, the state of its health, the uses to which it is put, the temperature to which it is exposed, &c. Notwithstanding these disturbing causes, if the vital forces are still active, the balance is fairly maintained. Thus, speaking in general terms, every 1000 parts of serum contain about 780 of water; and although this quantity, even in health, is subject to variation, and may sometimes rise to 790 or sink to 700, the first-named quantity is nevertheless present as a rule. Any diminution in the amount of water is quickly compensated for by the thirst which it creates, while any excess will be as rapidly removed by the skin

and kidneys,—in the one case as a chief constituent of the perspiration, and in the other as that of the urine.

Albumen exists in the serum at about the rate of 7 per cent.; it may rise a little above this, or sink as low as 6 per cent., consistent with health. In a plethoric habit of body there is a relative increase of the albumen; and on the contrary, in a debilitated condition, a diminished amount. The chief use of the albumen is to form fibrine by a higher degree of vitalization. Besides this, albumen is consumed in the production of the gelatine of the simple fibrous tissues, and in several of the secretions, as well as in the formation of those structures which are either epidermoid or horny. The source of the albumen is from the protein compounds of the food, and its proper proportion in the serum is regulated by its constant consumption for the above-named purposes. The presence of this material is easily demonstrated. Thus the addition of any mineral acid to the serum will throw down the albumen in the form of a dense white precipitate; or if the serum be exposed to heat, the coagulation of its albumen will take place. A temperature of about 165° of Fahrenheit will generally be required for this purpose, unless an unusually large amount is present, when a lower temperature will suffice. If, however, the albumen exists in a less than usual quantity, a much higher temperature will be required to effect its coagulation. A qualitative, but not a quantitative analysis of the serum, in so far as albumen is concerned, is thus obtained. A microscopic examination of solidified albumen does not, however, show that in acquiring this condition it has assumed any definite or structural form. It is at most granular.

It has already been stated that we possess no other means of obtaining serum except from coagulated blood. Nature, however, can readily separate it in large quantities from the other constituents of the *liquor sanguinis.* We observe this under many circumstances, and frequently when an animal is in a weak and debilitated condition from disease. It is then that the serous part of the blood exudes through the capillary vessels and accumulates in the areolar tissue or in some of the great cavities of the body. The diseases which commonly pass under the term dropsy are especially referable to a cause of this kind. These effusions may differ, and even considerably so, from pure serum in the proportions of albumen and saline matters which they contain; but nevertheless they are essentially of a serous nature, as is shown by their analyzation; and as such they afford a proof that the serum is capable of being expelled from the living vessels apart from the other constituents of the blood.

Salts of the Blood.—The saline matters of the blood are various, and are met with in the serum. They consist chiefly

of the phosphate of lime and magnesia, the tribasic phosphate of soda, with the chlorides of sodium and potassium. Besides these there are some other salts, which, although important in a physiological point of view, need not be especially mentioned in a paper of this kind. The phosphate of lime exists in considerable proportion, for when separated from the blood it is required to give strength and solidity to the bones, that they may be enabled to support the weight of the animal and resist the force of the muscles in the various movements of the frame.

THE FIBRINE.—This constituent of the circulating fluid may be considered as the basis of nearly all the solids of the body. It exists in the blood in a state of perfect solution, but possesses the remarkable property of becoming solid either within or without the vessels, and whether separated or not from the other component parts of the blood, provided this becomes stagnant. The coagulation of the blood is entirely due to the presence of the fibrine. The power of the fibrine to become solid led at one time to its being designated "self-coagulable lymph," a name by which it is described by John Hunter, in his great work on 'The Blood and Inflammation.' The term fibrine is, however, the more appropriate one, as expressing the fact that the material in solidifying arranges itself in the form of threads or fibres.

The means which are usually adopted to obtain fibrine consist of whipping the blood with a small bundle of twigs, immediately on its being drawn from the vessels. The fibrine under these circumstances adheres to the twigs particle by particle, until the whole of it is separated from the other component parts of the blood. On washing the mass thus obtained to free it from the small quantity of red colouring matter which it had enclosed, the fibrine is found to consist of white, tough, and elastic fibres interwoven together, and crossing each other in every possible direction. A microscopic examination of the smallest portion of one of these filaments reveals the further fact, that it also is made up of minute threads arranged in a similar manner to that of the whole mass.

The quantity of fibrine existing in the blood rarely exceeds three parts in every thousand in health; but like the albumen, it also is liable to variation, being both increased and diminished, according to different conditions of the organism. In a full habit of body, and especially if inflammatory action should supervene on this state of the system, the proportion of fibrine quickly increases until, according to Andral, in cases of active inflammation of the viscera it may amount to ten parts in a thousand. All pathologists admit a great increase under these circumstances; but there are few who place it quite so high as Andral.

Among the advantages consequently which are derivable from blood-letting in inflammatory affections, we must name that which arises from the withdrawal of a portion of this excess of fibrine by the operation. The benefit, however, is frequently not so great as might at first sight appear, arising from the circumstance that so long as inflammation persists, there is a suspension of the vital functions of the *affected* organ, and consequently a constant accumulation of fibrine, none of that substance being consumed for the nutrition of the diseased organ.

In diseases of the opposite character to those just alluded to, this important element of the *liquor sanguinis* is diminished in quantity, often sinking below even one part in a thousand. Hence a deficiency of fibrine is associated with typhoid fevers, as likewise with many other diseases of an asthenic nature; which are not found to yield until an increase of the fibrine begins again to take place.

In the cattle plague of Eastern Europe—the pathology of which terrible scourge was recently investigated and reported on by us to the Society, the presence of the *materies morbi* in the blood leads to an exudation of the fibrine from the capillaries of the mucous membranes. The blood of such patients does not clot after death, but remains perfectly fluid in all the larger vessels, and particularly in the veins, from being thus defribrinated. Convalescence is a sure sign of the reappearance of the fibrine; and if, at that time, blood be experimentally drawn from an animal, it will be found to form a soft gelatinous mass, the density of which will likewise be in proportion to the extent of the re-established health.

A loss of fibrine also so far alters the viscidity of the blood, that it does not circulate so perfectly through the capillaries as it otherwise would do, which produces a tendency to congestions, hæmorrhages, &c.

From what has been advanced it will be inferred that nutrition is mainly due to the fibrine, and as an appropriation of it for this purpose takes place in the systemic capillaries proper to each organ, so, on comparing its quantity in the arterial with that in the venous blood, a slight difference will be observed. According to Müller the proportion is as 29 to 24, the larger amount necessarily existing in arterial blood.

Chemically considered, there is not much difference between albumen and fibrine, while, on the contrary, both the physical and vital properties of the two fluids vary, as we have seen, to a very considerable extent. Much more might be said respecting this constituent of the blood, but it is unnecessary to add to these remarks, except to state that united with the serum, as we find it within the vessels, it constitutes the true *liquor sanguinis.*

We shall now proceed to a consideration of the red cells —the colouring matter of the blood.

The Red Cells.—It has already been said that the redness of the fluid is entirely due to certain cells which are floating within it, commonly designated the red particles. These bodies exist in such vast numbers, that many hundreds may be said to be present in every drop of blood, and it has been estimated that, on the whole, they constitute no less than an eighth part of the entire quantity of the circulating fluid. The discovery of the red cells is said to have been made by Malpighi, a celebrated Italian anatomist, who flourished in the latter part of the seventeenth century. Since his time they have excited the liveliest attention on the part of all investigators of the blood, which has led to a more complete knowledge of their structure, as well as of their uses in the animal economy, than had previously existed.

The aid of the microscope is indispensable even for obtaining cognizance of their presence, and our more extended knowledge of them is, in a great measure, due to the improvements which have of late years been made in the defining powers of this instrument. In man, and in most of the mammalia, the red cells are circular in shape, but in birds, reptiles, and fishes, they are oval. The exceptions to the circular shape in mammals are met with in the camel, the alpaca, and their allied species, in which the cells have, as in birds, an oval form. It is not to be inferred because the red cells are round that they are therefore globular shaped bodies; for, having flattened sides, they rather resemble the form of an ordinary coin. Correctly speaking, even their sides are not flat, but slightly concave, so that the cells may be described as bi-concave circular discs. This is their more general, and it may be said perfect shape, but as they readily imbibe fluid through their pellucid and colourless walls, so, by an addition to their contents, will their sides become first flat and afterwards convex, according to the amount of this which is absorbed.

Their size is likewise liable to great variation in different animals, and even in the same animal it is not uniform. In man their diameter varies from the $\frac{1}{3000}$ to $\frac{1}{4000}$ of an inch, and their thickness is about $\frac{1}{10000}$ of an inch. According to the measurements of Mr. Gulliver, given in an appendix to Gerber's 'Elements of General and Minute Anatomy,' the average diameter of the red cells of the horse is $\frac{1}{4706}$ of an inch, of the ox $\frac{1}{4267}$, the sheep $\frac{1}{5300}$, the pig $\frac{1}{4230}$, and the dog $\frac{1}{3542}$. In the goat and deer tribe they are smaller than in the sheep, reaching their smallest known size in the Napu musk deer, in which their average diameter is said by Mr. Gulliver not to exceed the $\frac{1}{12325}$ of an inch. Gradation in

their size in ruminants seems to prevail, the cells becoming smaller with the diminution of the size of the animal. This, however, is so far from being the case among the mammalia in general, that it is ordinarily stated that the bulk of an animal has little to do with the size of the red cells of its blood. It would appear, however, from recent investigations of Professor Quekett that the calibre of the capillary vessels of each individual animal is to be taken as a more correct standard of the size of the red cells than anything else—the two rising or falling together.

A great deal of discussion has taken place in former times, as to whether these cells were, or were not, nucleated in mammals; different observers of equal eminence maintaining opinions the very opposite of each other. The matter is one of some importance, as elucidating the probable means of their reproduction. Like every other part of the organism, they undergo changes which result in their ultimate dissolution or breaking up. If then they were nucleated it is evident that they would follow the same law as all other cells of this class in their reproduction, *namely*, the setting at liberty of their nuclei by disintegration, which would then develope into new cells. The opinion that they possess a nucleus has doubtless had its origin in the circumstance that, when viewed as transparent objects, their bi-concave form gives them an appearance of having dark centres, from the refraction to which the rays of light are exposed. That this is the true cause of the phenomenon, is proved by placing these bodies in a fluid less dense than that which they contain, when, by their imbibition of a portion of this, the dark spot disappears; they being thus changed from bi-concave to flat-sided or even double-convex discs. This procedure would, on the supposition that they were nucleated, tend, however, to bring the nucleus more into vision. The converse also is equally true, *namely*, the rendering the dark spot more distinct by emptying them of some of their contents, which is accomplished by placing them in a fluid of greater density than that which is located in their interior.

It is a singular fact that, when viewed in connexion with the blood-cells of other creatures, those of mammals should be *un*nucleated. In birds, reptiles, and the amphibia, the red cells possess a nucleus; they are also very much larger than in the mammalia, a circumstance which affords many advantages for the study of their structure, &c., in these creatures.

The proportionate quantity of the red cells to the other constituents of the blood has already been said to be as much as an eighth part. The quantity, however, is liable to much variation, depending on certain conditional states of the system. In animals of robust health it is always large, as also in those that are well fed and which undergo a fair amount of exertion

and breathe a pure air. Wild animals are said to have a relatively increased quantity when compared with domesticated animals, especially such as are placed under circumstances the very opposite to those we have just named.

Dr. Carpenter, in his 'Manual of Physiology,' says that it has been ascertained that even sex has its influence over the number of the red cells—the blood of the male possessing a larger proportion than the blood of the female. He also states that, estimating 1000 parts of the blood of a male to contain 132 parts of red cells, this quantity may rise to 186, or fall to 110, without the manifestation of disease; and that in the female, taking the average at 120, it also may rise to 167, or fall to 71, without producing any untoward results. Facts of this kind are of the first importance to the pathologist, and hereafter we shall see the influence these changes have in rendering animals susceptible to diseases which specially affect the blood; and that, while they point to the means which ought to be adopted for the prevention of disease, they render distinct also those which should be had recourse to for the restoration of animals afflicted therewith.

Important as the red cells may be in maintaining the health of an animal, they are evidently in so doing more immediately connected with respiration than with nutrition, and hence they are sometimes spoken of as the *respiratory element* of the blood. Their chief use is thus shown to be that of preserving the heat of the body. It is well known that all mammalian animals possess a power of maintaining a heat of their own, equal to about 99° of Fahrenheit, independent of the external influences by which they are surrounded: hence the term "warm-blooded" animals. This heat is evolved in every part of the organism, and is chiefly due to the union which is effected between the oxygen of the atmospheric air and the carbon of the system, leading to combustion, with its necessary evolution of heat and the formation of carbonic acid gas. A second cause of animal heat is to be found in the union of oxygen with the hydrogen of the system, forming watery vapour. By some it is likewise considered that electricity plays a not unimportant part in the production of the heat of the body, while others have attributed a portion of it to the changes which are ever taking place in the conversion of the fluids into solids in the building up the frame. The latter, however, would appear to be quite equalised by the reconversion of the solids into fluids, which is as continuously being effected.

The red cells are the chief conductors of oxygen into the system, as they are also the conveyors of the carbonic acid out of it; and in order to perform these essential offices, it is first necessary that they be brought into tolerably close contact with

the atmospheric air, which is effected by the passage of the blood through the lungs. By the act of inspiration the atmospheric air is conveyed by the windpipe and bronchial tubes into the air-cells of the lungs, where it is only separated from the blood itself by the thin walls of the air-cells and those of the capillary vessels which ramify upon them. The capillaries are arranged upon the air-cells after the form of a minute network, and they are so closely placed to each other, that although the vessels themselves do not exceed the $\frac{1}{3000}$th part of an inch in diameter, the spaces between them are considerably less than this. Thus the blood may be said to be spread out after the manner of a thin film, and every portion of it is consequently brought freely into contact with the atmospheric air; the delicate intervening tissues offering no real impediment to this taking place. The oxygen being seized upon by the red cells of the passing current, is by the onward flow and further distribution of the blood carried throughout the entire body, and thus reaching the capillaries of the several organs and tissues, it here unites with the carbon of the system, evolving heat, as has been previously explained.

In the expiratory act the carbonic acid gas—formed by the union of the oxygen and carbon—and the watery vapour—the product of the oxygen and hydrogen—are expelled from the system, by which means the blood, being first depurated and then *re*oxygenated by a fresh inspiration of atmospheric air, is again fitted for the purposes of life.

With these interchanges of gases, the blood is likewise well known to become altered in its colour, being rendered of a bright red hue by the absorption of oxygen while circulating through the capillaries of the lungs, and of a dark Modena red by that of carbonic acid while in its onward movement through the capillaries of the general system. Scarlet-coloured blood is commonly called *arterial*—as arteries supply all parts with the fluid for their support—and dark red blood is designated *venous*, being found within the veins after it has served its several purposes.

In order to explain the phenomenon of this change of colour, it is necessary to state that the red matter of the cells is contained in their interior, and is designated *hæmatine*. Mixed with this is another fluid, called *globuline*, which is closely allied to albumen in its chemical composition. With the *hæmato-globuline* are found the salts of iron—to the extent of about 6 per cent.—proper to the blood; so that the contents of the cells may be said to be very complex in their nature.

The alteration of the colour of the blood was until lately believed to be due to a chemical change wrought in the *iron of the hæmato-globuline* by the successive influences of oxygen and car-

bonic acid—this existing in the form of a *per*-oxide in arterial, and a *prot*-oxide in venous blood. More recent investigations have, however, disproved this, which is known as the Liebigian theory, by showing that when the hœmato-globuline is liberated from the cells, it does not change its shades of hue by an exposure to the gases in question; and further, that after all the iron is removed, its red colour still remains.

The absorption both of oxygen and carbonic acid by the blood is found to produce a *physical* change in the condition of the red cells. Thus by the influence of the first-named the cell-walls are contracted or shrivelled, while by the latter they are dilated or expanded. These alterations in form necessarily lead to an alteration in the refraction of the rays of light, and it is now thought, that the bright-red hue of arterial and the dark hue of venous blood are mainly due to this simple cause. The action also of carbonic acid on the salts of blood contained within the serum is said to have an influence in producing the Modena red colour.

In concluding this part of our subject we may incidentally direct attention to the fact, that the inhalation of ether, chloroform, and other similar anæsthetic agents, produces a dark-coloured blood, which is found under such circumstances to be flowing not merely through the veins, but the arteries also, and of necessity but imperfectly supporting the various functions of organization and life.

We come now to speak of the only remaining constituent of the circulating fluid, which it is necessary to direct special attention to, *namely*—

THE WHITE CORPUSCLES.—These bodies, although exceedingly numerous, are considerably less so than the red. It has been computed that about one white to fifty red cells exists in a healthy state of the system, and in almost every other respect the white differ from the coloured cells. In size they exceed them; for while the average dimension of the red cell is about the $\frac{1}{3500}$th of an inch, these measure as much as the $\frac{1}{2500}$. Their form also is different, the white cells being globular-shaped bodies and not flattened discs. Again, their contents are found to be granular when viewed with a microscope, which gives them a dark dotted-like appearance totally unlike the red cells.

Physiological anatomists are not agreed as to the origin and use of the white cells; but by most they are regarded as identical with the cells which are met with in the chyle before this fluid is mingled with the blood proper: and certainly they would appear not to be essentially different from chyle cells when microscopically examined. Some have viewed them as ministering

directly to nutrition, by the setting at liberty of their contents, which are then found to have a tendency to fibrilisation; while others have thought that they were the elaborators of the albumen into fibrine. Others, again, consider that they originate the red cells by a higher degree of development, and this probably is their chief use.

The circulation of the white cells through the vessels is slower than that of the red; and as they are often found close to the sides of the interior of the capillaries, as if adhering thereto, and out of the principal force of the passing current, this circumstance has given support to the view of their ministering immediately to nutrition. The opinion receives some further confirmation from the fact that wherever active development is going on, there is always found a relatively greater number of these cells.

The blood of plethoric animals is rich in white cells: besides which these bodies seem to have a remarkable tendency both to increase in number and to accumulate in the vessels when diseases of an inflammatory nature supervene on such a state of system. In that abnormal state of the blood also, which is ordinarily termed buffy blood, and which belongs especially to many inflammatory affections, the white cells help in a great degree to make up the so-called sizy or buffy crust of the blood. We thus see that variation in their number and also in their comportment within the vessels takes place when disease exists, showing that they, in common with every other constituent of the blood, undergo important changes under such untoward circumstances.

We must not, however, anticipate that which has to be stated with reference to blood-diseases; and, therefore, having now described the chief constituents of the circulating fluid, and shown the several important offices which each fulfils in the promotion of health and development, we purpose to conclude the present paper, intending in our next to speak of the circulation of the blood and the phenomena connected therewith, with an especial view of explaining the pulse and the changes it undergoes both in frequency and character, depending on certain morbid states of the system. Besides this, it is our intention to direct attention to some of the maladies which have their origin in a changed condition of the blood itself.

[To be continued.]

XIV.—*On the Feeding of Stock.* By P. H. Frere.

The object which I have in view in the following article is to speak of those modifications in the management of stock which the experience of the last eight years, in connexion with the changes of the times and the gleams of light cast upon the subject by scientific research, has induced me to adopt, reserving for a future occasion an account of those changes in the culture and cropping of the land which were in unison with, if not a necessary consequence of, the system adopted.

This paper may be considered as the first portion of a retrospect of the management of a light-land arable farm, in a dry part of England, better suited for the growth of corn than for pasture or even roots; consequently, the conclusions drawn and the estimates of cost involved will at best admit of exact application only under similar circumstances, not only in the soil and climate, but also in the cost of labour both of men and horses, varying as these do both in the weekly wages paid or expense incurred for keep, and in the amount of work executed at that cost.

The farm in question consists of 460 acres, running in a long strip from the high grounds in Cambridgeshire which border upon Essex and Suffolk to the old limits of Newmarket Heath. It is all arable, with the exception of about 8 acres of indifferent meadow. About 80 acres on the higher ground are slightly capped with clay; 210 acres on the slope are a light chalky loam, and 160 are heath-land, varying from a brown sandy loam to a black heath sand, resting on a chalk rubble.

My chief encouragement in taking the farm into my own hands in 1851 was derived from Lord Portman's account of his management of Shepherd's Corner Farm, in Dorsetshire, as stated in detail in the fourth and eighth volumes of the 'Journal.' My aim was not so much to reap an immediate profit, as to avoid loss, and look to the increased value of the stock and crop, as well as of the land itself, for my ultimate reward. I believe that I have realised this aim. I believe likewise that more sanguine expectations would have met with disappointment.

In comparing my home management with the most approved theories of modern farming, I shall plainly state the chief points of conformity or divergence without always justifying my practice. In some cases, if the master had been more at home, and at leisure, more of change would have been attempted. What was done was carried out by a practical man, responsible to his employer to make the farm pay its way, and consequently left to

act ultimately upon his own judgment. The course taken, therefore, was in the main such as approved itself to the mind of the practical man, not the experimental farmer.

Stock.—I give the precedence to this branch of farm management, because of late years it has been the surest staff on which the farmer could lean, because rotations and cultivation must accommodate themselves to this object, and because though all are conscious that we can no longer rely as heretofore on the corn-crops for paying the rent, perhaps none of us have been able sufficiently to throw off the trammels of custom and association, which led him to look for profit first to the stack rather than to the stall; a view which the unreasonable custom of taxing the turnip-crop with the duty of doing all the scavenger's work for the whole rotation, besides leaving a dressing of manure behind without any allowance made, tended greatly to foster.

With regard to stock, both soil and situation led me to look to the sheep rather than the ox, and very little examination of the results of feeding sufficed to justify this preference.

The custom of the district, which consists mainly of arable-land and grows a great breadth of straw, was, and still is, to buy lean beasts in the autumn at fairs, and either to fat or sell them fresh in the spring. I have tried this system in many ways, but could hardly ever arrive at a satisfactory result. At the very best, the price made by the bullock when fat only amounted to four-fifths of the purchase-money and cost of food on the average of a lot, but more frequently only to three-fourths or two-thirds. If I went into a fair I had a dread of bringing home pleuro-pneumonia as the consequence of heating and chills from over-driving, if not as the result of direct contagion; or else of buying beasts that had been so unequally kept that they would not answer the whip when put to good food. Stock bought at auctions on farms of established character made exorbitant prices, and even then, perhaps, the event proved that the animals had, in anticipation of the sale, been too much pampered for steady feeding. If the stock were "held over" and sent out to graze in summer, a risk of infection was incurred, and no security obtained for an adequate and steady supply of feed. The conclusion, therefore, at which I arrived, was to keep no more beasts than I found necessary for making my straw into good manure, and, as far as might be, to rear my own stock from the first, buying nothing but the very best calves that I could procure, with the conviction that a difference of 5*s.* in the price of a calf will often put 5*l.* on to the value of a good 3-year-old beast, the food being the same.

These calves are kept in small lots from the time of weaning

up to the last, and do not often disagree. They rarely go outside the yards, and if a flush of grass in spring tempts us to let them have a run with the cows we generally repent it.* Mown sainfoin affords them a cooling food in summer, and if a gap occurs between the first and second cutting of this and of the clover crop, there is a small reserve of mangold to meet the exigence of the moment. Animals thus selected, thus reared from the first, never stinted, never forced (except for a few weeks at the last), in comfort as to their lair, their comrades, and their feeders, will sometimes pay for their food; but this result is very exceptional where beasts are bought and fatted according to the common course of management in the eastern counties.

In confirmation of my opinion that yard-fed beasts, even with economical management, successful growth, and a good sale at last, will hardly ever be found to leave a direct profit, if all expenses are fairly taken into account, I have been at the pains to trace out the history of two calves, reared on my farm and sold at Christmas, 1857, at the age of 3 years and 4 or 5 months, for 95*l.* the pair. If the two had thriven equally well up to the last, the price would have been 100*l.*, but, even with this drawback, I think the picture will on the whole represent the bright side of grazing, these two calves being the pick of the lot, one of them possessing special powers of thriving and the price made being indubitably good for the age of the stock. I shall purposely leave my calculation without altering a figure, as I made it step by step and year by year in the rough draft, in ignorance how the balance would be found to stand at the last, when the sum of the items in this, one of my most successful attempts in grazing, came to be cast up.

Estimate of Total Cost of Yard-feeding a 3 years and 4 months old Beast for Christmas Beef.

1854 to 1855.

	£.	s.	d.
1854. Michaelmas. Valuation, 6 calves, 18*l.*; 2 months-old calf	3	0	0
52 weeks' keep, at 2*s.*	5	4	0
	8	4	0

1855. Valuation at Michaelmas, 6 head at 7*l.*; the best 7*l.* 10*s.*, estimated loss 14*s.*

* At the present moment (June, 1860), I am informed that one yearling has probably lost three stone from going out to grass for a month, though kept in the yard at night, and receiving a bait of cake. The whole lot have decidedly gone back: they would not have been sent out, but that this trying winter, and this wet and cold spring, have reduced the swathe of sainfoin to about one half of last year's bulk.

1855 to Michaelmas, 1856.

Keep per day.	Per week. s. d.	£. s. d.
Barley-meal, ½ peck..	2 6	
Cake (rape or linseed), 3 lbs.	1 9	
Roots, &c.	0 6	
52 weeks' keep at	4 9 =	12 7 0
1856. Valuation, 6 head at 14*l.*; the best worth 15*l.*: loss, 5*l.* 11*s.*		20 11 0

1856 to 1857—Keep to Michaelmas.

Per day.	Per week. s. d.	
⅔ peck of bean meal	4 8	
4 lbs. of oilcake at 15*d.* per stone	2 6	
Turnips	0 10	
52 weeks' keep at	8 0 =	20 16 0
1857. Valuation (nominal) 35*l.*..		41 7 0

1857—Keep from Michaelmas to December.

Per day.	Per week. s. d.	
1 peck of meal	7 7	
6 lbs. of cake	3 9	
Turnips, 1 bushel at 2½*d.*	1 6 nearly.	
Hay	1 0	
9 weeks' keep at	13 10 =	6 4 6
Price made $\frac{95}{2}l.$=47*l.* 10*s.*	Total cost	£47 11 6

The price put upon the barley-meal in the year 1855-6 is calculated as follows: 4 bushels of barley (worth with grinding about 16*s.*) will give about 22 pecks of meal. To fix, therefore, the value of 3½ pecks of meal, we have—

$$\overset{\text{Pecks.}}{22} : \overset{s.}{16} :: \overset{\text{Pecks.}}{3{\cdot}5} : A.$$

$$A = \frac{16 \times 3{\cdot}5}{22:} = \frac{56}{22} = \overset{s.}{2}\ \ \overset{d.}{6} \text{ nearly.}$$

At this price I think the barley-meal cost more than it was worth, but it is not set above its value at *that time.*

The price of the bean-meal is thus arrived at: it is reckoned that 4 bushels of beans will give between 19 and 20 pecks of meal. The sack of beans and cost of grinding are valued at between 19*s.* and 20s., so that one peck of meal is taken to cost nearly 1*s.*

The cake eaten by the young stock in 1855-56 varied with the season of the year. In winter some rape-cake was used; in summer, linseed. Not to overburden the estimate with details, a mean value between the price of linseed at 1*s.* 4*d.* per stone, and rape-cake at 11*d.* per stone, has been taken, which, allowing for a little waste, may be fairly set at 1*d.* per lb. The turnips are valued at 2½*d.* a bushel, allowing 40 heaped bushels to the ton—or at the rate of 8*s.* 4*d.* per ton.

If we now proceed to criticise this estimate, the first objection that may be made to it is that the quantities are estimated partly by measure, partly by weight. Our practice has been amended of late in this respect, so that, when practicable, all quantities are now taken by weight. When this is generally done, and a uniform standard of weights established, we shall generalize more easily, if not more *safely*, than we can do at present.

1st. As to the estimate of 5*l.* 4*s.* for one year's keep of a calf from 3 to 15 months of age, it is not easy to give this calculation with more precision. The calves were supplied at first with malt-combs, bran, oil-cake, and meal mixed with cut hay without stint. The quantity consumed was always varying and steadily increasing. They soon ate 1 lb. of cake a-day, and probably for the last six months 2 lbs. per day; or, at last, if other nutritious substances like bran and malt-combs were withdrawn, at the rate of 3 lbs. of cake per day.*

The valuation only shows a loss so far of 14*s.*, when the young calf has been valued as high as 45*s.*; so that thus far I think there is not much to be dissatisfied with. But when we come to the next year 1855-56, the keep allowed was not judicious: the half-peck of barley-meal at 2*s.* 6*d.* was a mistake, but the prospects of stock-farming were encouraging, and a desire was felt to push the young beasts on. The allowance of food that would have been substituted for this in 1858-59 would have been probably—

For Yearlings. Per day.	Per week. *s.*	*d.*
3lbs. of cake	1	9
2 lbs. malt-combs or bran	0	8†
Roots or stover	0	6
	2	11 or say 3*s.* 0*d.*
Instead of	4	9

The cost of cake, but not that of keep, might be diminished in summer when green stover came in.

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* According to an estimate of Mr. R. Bond (at the Discussion of the Central Farmers' Club, Dec. 1858), calves, from the second to the eighth month, should be charged at the rate of 1*s.* 6*d.* per week; and from the eighth to the fourteenth month at 2*s.*

† Or at the rate of about 5 guineas per ton.

Now this estimate of 3*s*., instead of 4*s*. 9*d*. per week, for the second year's keep would make the difference between 12*l*. 7*s*. and 7*l*. 16*s*. on the year, or of 4*l*. 11*s*., and leave us with only a loss of 1*l*. instead of 5*l*. 11*s*. on the picked animal, valued at 15*l*. at 2 years and 3 months old,—a value as high as is, I think, commonly attained at that age by animals kept in good store condition.

If we now proceed to the year 1856-57, the fattening process may be considered to have commenced, and that under favourable circumstances; for, as meat was scarce, a butcher had promised to give 50*l*. a-piece for the bullocks in 15 months' time if they were fatted to his satisfaction,—an encouraging offer, as the weight attained would not probably much exceed 100 stone, of 14 lbs., so that the meat would cost nearly 10*s*. per stone. The butcher was highly satisfied with the quality of the meat, which I myself also proved: it was nicely mottled and quite fat enough. This is noteworthy, because many will think that the beans, and consequently the albuminous element supplied, had undue prominence in the diet. I can only say that repeated observation of benefit received from mixing or substituting bean-meal for that of other grain, has led to its constant use on the farm at some inconvenience, because beans are not grown on the land and are not plentiful in the neighbourhood. If my experience differs from that of others in this respect, a reason may be found in the fact that I mix meal and cake almost exclusively with cut straw-chaff, whilst others may use hay freely for the purpose; and in my case the albumen in the bean may be required to supply the defect of nitrogenous substances created by the substitution of straw for hay. The supply of two-thirds of a peck, or between 8 and 9 lbs. of unmixed bean-meal is not, however, a practice to be upheld. Under like circumstances the proportions would now be thus varied:—

	lbs.		lbs.
Instead of bean-meal	8	Bean-meal	3
,, oil-cake	4	Wheat or barley meal	3
	—	Oil-cake	6
	12		—
			12

would be substituted.

The whole cost of keep furnished to a 2-year-old would now, except for special reasons, but little exceed that of a yearling, costing in winter—

Per day.	Per week. *s.*	*d.*
2 lbs. of cake (rape, cotton, or linseed), at about 1*d*. ..	1	2
2 lbs. of meal, at 13*d*. per stone	1	1
2 lbs. of malt-combs and bran	0	8
Turnips, 2 bushels, at 2½*d*.	0	5
Say, 3*s*. 6*d*. per week	3	4

In summer, if green stover is given, or a little mangold, according to circumstances, the cost with some 2 or 3 lbs. of cake will not be much reduced. I shall show farther on, that on such keep well-conditioned stock may pay their own way, especially if the times give them a little help.

Coming to the keep given in the last 9 weeks of preparation for the market, which has been estimated above at nearly 14*s.* per week, the experience of 1859 would both vary the materials and diminish the cost. The allowance made last autumn, under like circumstances, was—

Per day.	Cost per week.	*s.*	*d.*
6 lbs. of linseed	(3 stone at 15*d.*)	3	9
6 lbs. of meal, half bean, half wheat, at 1*d.*		3	6
6 lbs. of hay	(3 stone at 5½*d.*)	1	4½
6 lbs. of locust-beans (6*l.* 15*s.* per ton), 3 stone, at 10*d.*, nearly		2	6
84 lbs. of swedes	(8*s.* per ton*)	2	0½
		13	2

It will be observed that here the albuminous substances are diminished and the fat-producing food increased. The locust-beans are in their proper place when from long feeding the animal is getting dainty; their want of nitrogen being unimportant for the last stage of fattening, and overlooked for the nonce in the account of the manure. The wheat-meal is mixed with the bean-meal, not as being cheaper or better in any way than the latter for feeding purposes, but simply because there was a glut of the one and a deficiency of the other article. In the case under examination no exception can be taken to the last 15 months of keep on the score of profit:—

	£.	*s.*	*d.*
Each beast was valued at Michaelmas, 1856, at ..	15	0	0
They cost for the year	20	16	0
For 9 weeks over	6	4	6
	42	0	6
They averaged in price	47	10	0
	42	0	6
Leaving a gain of	£5	9	6

which just neutralised the previous loss. It has been stated that this beef cost nearly 10*s.* per stone. If the price had been

* Cost of 84 lbs. (or 6 stone) of Swedes, at 8*s.* per ton

$$= \tfrac{3}{4} \text{ of } \frac{1}{20} \text{ of } 8 \times 12d. = \frac{3 \times \cancel{8} \times 12}{\cancel{4} \times \underset{10}{\cancel{20}}} = \frac{36}{10} = 3\tfrac{1}{2}d. \text{ nearly.}$$

reduced to 1*s.* on 100 stone (as the average weight of the bullocks), even the *ultimate* profit of 5*l.* per head would have disappeared.

I will next give an outline of the cost of 4 young beasts now on the farm, which have been fed economically and thriven well. In consequence of small variations in the diet, this statement cannot be readily given in minute detail; but the following items of expense are under rather than over stated.

1857 to 1858.			£.	s.	d.
Midsummer, 1857. One calf			2	5	0
52 weeks at 2s.			5	4	0
Entered in bailiff's valuation at Michaelmas, 1858 £6 0 0			7	9	0
1858 to 1859—52 weeks' keep.					
Per day.	Per week. s.	d.			
3 lbs. of cake	1	10			
2 lbs. of malt-combs and bran	0	8			
Roots, about 2 bushels per week	0	6			
52 weeks keep at	3	0 =	7	16	0
Valuation at Michaelmas, 1859 .. .. .. £15	0	0 =	15	5	0
1859 to 1860—34 weeks' keep.					
	Per week. s.	d.			
2 lbs. of oilcake, at 15*d.* per stone	1	3			
2 lbs. of meal at 13*d.*	1	1			
Roots, about 2 bushels	0	6			
2 lbs. of malt-combs and bran (at about 5*l.* 5*s.* per ton)	0	8			
38 weeks at	3	6 =	6	13	0
2 weeks.					
4 lbs. of oil cake	2	6			
4 lbs. of meal	2	2			
Roots	0	6			
2 lbs. malt-combs, &c.	0	8			
2 weeks	5	10 =	0	11	8
			£22	9	8

These beasts were weighed on the 25th of June last, and their live weights, taken *in the afternoon*, found to be as follows:—

	Cwt.	st.	lbs.		Stone.
No. 1.—	12	4	0	or multiplied by $\frac{56}{100}$	56·0
No. 2.—	12	2	4	.. ..	54·7 nearly
No. 3.—	11	4	0	.. ..	51·7
No. 4.—	10	3	0	.. ..	46·7*

* This bullock since died by accident in July, and was found to weigh 46 stone 2 lbs. Two of the others have gained more than 1 cwt. of live weight in 1 month; the 3rd little more than ½ cwt.

Mr. Horsfall states that a good beast, fairly fat, will give 59 lbs. of meat for 100 lbs. of live weight; but taking into account the condition of my beasts, the hour of weighing, and other circumstances, an average of 51 stone is a fair estimate. Now these 51 stone would be worth,

	s.	*d.*		£.	*s.*	*d.*
At	8	0	per stone	20	8	0
"	8	6	"	21	13	6
"	9	0	"	22	19	0

We have seen that their cost has been *at least* 22*l.* 9*s.* 8*d.*, so that 8*s.* 6*d.* is the lowest price that can save us from material loss even under these favourable circumstances.

But in these estimates no account has been taken hitherto of the value of the straw eaten, the cost of cutting it into chaff, the cost of attendance, or of insurance against risk (no trifling consideration in these days of pleuro-pneumonia); all these are outstanding charges against the manure account.

And first, as to the expense of cutting straw into chaff, the author of our Prize Essay estimates this at 6*s.* per ton, and he is right in the main even where horse or steam power is employed; he puts 4*s.* per ton as a minimum price when the work is done under the most favourable conditions.

If then we assume that the beasts receiving no hay consume 20 lbs. of cut straw in a day, or 140 lbs. per week; the cutting this quantity at 6*s.* per ton would cost 4½*d.* per week;* at 4*s.* it would cost 3*d.*, or if done by hand 6½*d.*;† and we must ask further, what is the difference between the value of the straw, and that of the excrement derived from the straw?

On this head, however, our information is very imperfect; for

---

$$\overset{\text{Ton.}}{1} : \overset{s.}{6} :: 140 : A.$$

$$\text{or } \overset{\text{lbs.}}{14} \times \overset{\text{st.}}{8} \times \overset{\text{cwt.}}{20} : \overset{s.}{6} \times \overset{d.}{12} :: 140 : A.$$

$$A = \frac{\overset{3}{\cancel{6}} \times 12 \times \cancel{140}}{\cancel{14} \times 8 \times \cancel{20}} = 3 \times \frac{12}{8}$$

$$= 3 \times \frac{3}{2} = \frac{9}{2} = 4\tfrac{1}{2}d,$$

† Our custom is to pay for this by the score of fans at 3*s.* per score. The fan consists of six bushels, weighing about 6½ lbs. a-piece, or 39 lbs. the fan. We have, therefore,

$$39 \times 20 : \overset{s.}{3} :: \overset{\text{lbs.}}{140} : A.$$

$$A = \frac{\overset{s.}{3} \times \overset{d.}{12} \times \overset{7}{\cancel{140}}}{39 \times \cancel{20}}$$

$$= \frac{84}{13} = 6\tfrac{1}{2}d. \text{ nearly.}$$

Practical men have failed hitherto to examine and collect those data from which alone conclusions could safely be drawn, and consequently scientific men have not been armed for those investigations which would belong to their province of research.

But farmers cannot wait until science has spoken authoritatively; they must act directly, and therefore their practice must be guided by the safest approximate estimate which they can form.

On the question of the value of the excrement derived from the consumption of 1 ton of straw as food, there will not, I think, be as wide a divergence of opinion as on that of the worth of that same amount in its primary state as straw.

Those who set the highest value on straw for feeding purposes rest their views chiefly on the supply of carbonaceous matter which it contains, and its fitness for digestion, assimilation, and combustion in the animal economy. The worth of the residuum would, in their view, depend chiefly on the minerals contained in it, to which they might not attach so much importance as writers of a different school.

Hence those who put the highest value on the straw may possibly put the lowest on the residuum. All, therefore, whether they value straw at 35*s.* per ton, or at 20*s.*, may concur in estimating the residuum at about 10*s.* per ton, and in charging the stock with *at least* 10*s.* per ton for the nutriment extracted, the only point with which we are here concerned. At this rate the animal eating 140 lbs., or 10 stone $= \frac{1}{16}$ of 1 ton per week must be charged $\frac{10 \times 12d.}{16} = 7\frac{1}{2}d.$ for straw consumed in a week.

The item of attendance yet remains to be assessed.

A man at 11*s.* a-week, with a boy to help him at 4*s.* (in all 15*s.*), will be wanted for 30 head of stock, giving an average cost of 6*d.* per head.

We thus arrive at a charge of

	s.	*d.*
For straw consumed	0	7½
„ expense of cutting straw	0	4½
„ attendance	0	6
In all	1	6

per week as an outstanding claim against the value of the manure.

If, further, we adopt the estimate of the author of the Prize Essay on Straw, that a beast fed in box, or covered yard, makes 1 ton of manure per month, and allow 8*s.* per ton as a fair value for manure of such quality; if, moreover, we allow 24 lbs. per

week for litter required in a covered yard, or, in round numbers, 1 cwt. per month at 1*s.*, we shall have the following charges against the manure account:—

	s.	*d.*
4 weeks' chaff-cutting and straw for food	4	0
4 weeks' attendance, at 6*d.*	2	0
Straw used for litter, about 1 cwt.	1	0
	7	0

	s.	*d.*
Value of manure	8	0
Per contra outgoings	7	0

leaving us only 1*s.* per month as insurance against risk and losses, and for profit.

This estimate is based upon the quantity and value of manure made by feeding in boxes, because such is the only manure of standard value in which the proportion of excrement (liquid and solid), litter, and water, can be accurately determined; but the question before us turns solely on the value of the excrement, which depends only on the food given, quite independently of the amount of water or litter with which it is combined. If the water be nearly doubled, and 1 cwt. more of litter provided, at the extra cost of 1*s.*, the 2 tons of manure thence resulting would be fairly valued at 4*s.* 6*d.* each.

We have hitherto been looking at the comparatively favourable side of the picture of stall-feeding, let us now take a case in which the unfavourable features predominate, yet without the intervention of any disaster.

The lot referred to consisted of seven young beasts, of which one home-bred (neat, but small) was by a bull of Mr. Jonas Webb; two others were purchased for me by one of the best farmers in Cambridgeshire by auction, at the farm on which they were reared, and kept by me for one year as store-beasts, and the remaining four (very well-bred young stock) were bought in like manner at a sale close to home, ready to be fattened, and considered to be well bought by a very well-known Cambridgeshire farmer, who was himself a purchaser at the same time, and about at the same rate. These details are material, because success in grazing does no doubt greatly depend on the judgment shown in the selection of store-stock.

My detailed account will commence only from Michaelmas, 1859; but a retrospective glance over the year 1858-59 will be also desirable.

At Michaelmas, 1858, my home-bred, No. 1 of this lot, was valued at 11*l.*; Nos. 2 and 3 were bought shortly after Michaelmas, at 13*l.* No doubt these latter were bought very dear; at such a rate as to make the purchaser hesitate; but store-stock

were high at the time, and disease very prevalent, so that it was important to secure healthy animals whose antecedents were well known; it may, however, be admitted at once that they cost 1*l.* per head more than they ought to have done.

On reference to the memoranda of the year the following entries are found:—

Store Beasts—Keep per day.	Per week. s.	d.
4th week—12 lbs. of linseed cake per week	1	2
12 lbs. of rape cake per week	0	10
Chives or malt-combs, ½ bushel	0	6
	2	6

10th week—18 lbs. of linseed, instead of 12 lbs.
18 lbs. of rape, instead of 12 lbs., with a consequent increase of 8*d.* in the cost.
20th week—6 lbs. of bean-meal per day substituted for the oil-cake, &c.

On this basis, therefore, the keep cannot be estimated (exclusive of straw, chaff, and litter) at less than 2*s.* 9*d.* per week, giving a total of 7*l.* 3*s.* on the whole year. The home-bred having been valued the year before at 11*l.*, and increased in value to 15*l.*, shows

	£.	s.	d.
A gain of	4	0	0
To meet an expenditure of	7	3	0
And consequently a loss on the year's feeding of	3	3	0

I find Nos. 2 and 3 valued in a lot of seven at Michaelmas, 1858, at 14*l.* a piece; they were worth 2*l.* a-head more than two of this lot, but rather less than the other three, so that they cannot have been set at more than 15*l.*, showing a rise in price of only 2*l.* on the year, and a loss of 5*l.* 3*s.* in consequence partly of the general fall in the value of stock at that time, and partly of the dear rate at which they were purchased.

I will now give in more detail the expense of the keep of the 7 beasts during 28 weeks from Michaelmas, 1858, the mean time of their feeding, as they were drafted two or three at once at the commencement of the 28th, 29th, and 30th week from Michaelmas:

Cost of 7 Beasts.

	£.	s.	d.
No. 1.—15*l.*, home bred			
„ 2.—15*l.*, home store	45	0	0
„ 3.—15*l.*, ditto			
„ 4.—16*l.*, bought second week in October			
„ 5.—16*l.*, ditto	32	0	6
„ 6.—12*l.* 12*s.*			
„ 7.—12*l.* 12*s.*	25	4	0
	102	4	6

				£.	s.	d.
Brought forward				102	4	6

Cost of Keep.

	£.	s.	d.		£.	s.	d.
7 weeks from Michaelmas for the 3 first beasts, at 3*s.* 6*d.*	3	13	6				
6 weeks' keep of the 4 last bought, at 6*s.*..	7	4	0				
The cost of 7 beasts before tying up	10	17	6	=	10	17	6

Keep per day.	Cost per week. s.	d.		£.	s.	d.
8th week—¾ peck of wheat-meal	5	0				
4 lbs. of cake, 15*d.* per stone	2	6				
Turnips, &c.	1	6				
To 13 weeks' keep of 7 beasts, at	9	0	=	40	19	0
21st week—¾ peck of meal (wheat and bean mixed)	5	3				
4 lbs. of cake	2	6				
¼ of fan of cut hay	1	6				
Swedes, 5 bushels per week	1	0				
To 3 weeks' keep of 7 beasts at	10	3	=	10	15	3
24th week—6 lbs. of meal	3	6				
6 lbs. of cake	3	9				
3 lbs. of locust beans	1	9				
Hay, as before	1	6				
Swedes, as before	1	0				
5 weeks' keep of 7 beasts, at	11	6	=	20	2	6
				184	18	9

	£.	s.	d.
Cost per head $\frac{184l.\ 18s.}{7}$	26	8	0
Average price made	22	10	0
Loss per head	3	18	0

These beasts were sold in one lot at an average of 22*l.* 10*s.* per head, but we had our own estimate of the weight and value, which was as follows:—

No.	Stone (14 lbs.)		£.	s.	d.	
1 ..	.. 58 worth, at 8*s.* 9*d.*		25	7	6	
2 ..	.. 56 ,, ,, ...		24	10	0	
3 ..	.. 56 ,, ,, ...		24	10	0	
4 ..	.. 47 ,, ,, ...		20	11	3	
5 ..	.. 52 ,, ,, ...		22	15	6	
6 ..	.. 45 ,, ,, ...		19	13	9	
7 ..	.. 45 ,, ,, ...		19	13	9	
	7) 359		157	1	9	= Cash £157 10 0

Average 51 stone 4 lbs., making, at 8*s.* 9*d.* per stone, 22*l.* 8*s.* 6*d.*, or very nearly 22*l.* 10*s.*, the price given.

Now if these estimates were not correct, at all events they

indicated impartially the comparative weight assigned to each beast; and if we refer back to the estimated value of each at the commencement, we shall see how much the result varies in each instance in an economical point of view.

	£.	s.	d.
The cost of keep for the 3 first beasts for 28 weeks will be found to be 11*l.* 9*s.* 9*d.*, or say	11	10	0
Add to this their prime cost	15	0	0
And the total outlay per head is	26	10	0
Indicating in case of No. 1. a loss of	1	2	6
" " on No. 2 * of	2	0	0
" " on No. 3 of	2	0	0

But the case stands very differently with the four last. These are severally chargeable for keep with 12*l.*:—

	£.	s.	d.
The price of No. 3 was	16	0	0
Add keep	12	0	0
Together	28	0	0
Deduct value	20	11	0
Loss	7	9	0
No. 5, having likewise cost	28	0	0
Shows a value of	22	15	0
And a loss of	5	5	0
No 6 cost	12	12	0
Add keep	12	0	0
	24	12	0
Value	19	13	0
Loss	4	19	0
No. 7, like No. 6, a loss of	4	19	0

The four last numbers, when put up to fat, looked as sleek and well-bred animals as are commonly seen; and many would have preferred them to my own rougher-looking lot, but they were pampered and dainty.

I gave them some of Thorley's cattle-food, and I am bound to say that it appeared to produce a satisfactory effect when the beasts were off their feed. There is this drawback, however, to its use, that if commenced it should not be discontinued.†

* This is independent of the heavy loss on No. 2 and No. 3 as stores.

† I had before used some of Henri's food for some aged cart mares which had lost flesh, and been at least as well pleased with the result. Without entering into the comparative claims and merits of these and other preparations of medicated food, which have attracted a very unequal degree of public notice, I may observe that I have considered them as tonic medicines rather than as food; and, as such,

If we examine the details of these results we may learn several lessons by regarding the different animals as in some degree typical of a class. I think that in respect of the three first a better economical result might have been attained if they had not been unduly pushed for the sake of their dainty comrades. Nearly the same weight might have been attained at some cheaper rate of feeding, so that the money lost on 2 and 3 might perhaps have been saved, and a small profit shown on No. 1. At the same time the rate of feeding was not above the traditional practice of the district, and the results, as concerns the three first beasts, a good average one according to such practice, showing a probable increase of nearly 20 stone in 21 weeks. A rise in the market which occurred at the time of sale was, moreover, unusually opportune.

No. 1 exhibits the advantage of blood even in a well-bred lot of animals; he was mellow, though small in size.

On the other hand, when my neighbours, like myself, play with these manure-making machines, I believe they not uncommonly burn their fingers quite as much as I did with Nos. 5, 6, 7; or if one of the lot gets out of sorts, as much as I did with No. 4.*

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available for ailing rather than healthy stock. It is, indeed, conceivable that under an artificial system of diet, a constant supply of that which is medicinal may be desirable, to make good a defect originating in that which is artificial in the system, in the same way that antiscorbutics are rightly given indiscriminately to a crew at sea. If grasses, whether in their green or dried state, be withheld, the straw substituted may be defective in some element which is of service, rather to aid the process of digestion by supplying the requisite juices, than that of assimilation by contributing directly to nutrition; the presence and influence of this element may be detected rather by flavour than by an analysis, which refers chiefly to primary chemical substances. I do not believe, however, that where roots and bean-meal are judiciously supplied to healthy stock, any defect in the diet will practically arise from a want of grass, the natural food of the animal. At any rate, if farmers buy medicinal stimulants, they would naturally prefer to buy them by themselves, and mix them with food for themselves; giving the preference to that source of supply where the ingredients are declared, and consequently their presence in due proportion the more readily ascertained.

* Mr. Bond, in the discussion before referred to, gave the following as the final balance-sheet of an intimate friend, arising from old-fashioned fatting of bullocks:—

Dr.	s.	d.	£.	s.	d.
8 old beasts at 19*l.*			152	0	0
20 weeks' keep, at an average of—					
10 lbs. of cake per day, at 1*d.* per lb. ..	0	10			
3 bushels of mangold, at 2*d.* per bushel	0	6			
Half a peck of meal at 4*d.* (a low estimate—P. H. F.)	0	4			
	1	8			
1*s.* 8*d.* a day × 8 beasts × 140 days			93	6	8
Attendance			5	0	0
			£250	6	8

What light then do these instances of feeding throw upon the present state of the meat market?

One great change in the aspect of the present time is, that whereas of old the bread consumer had to pay in part for the supply furnished to the consumer of meat, now, each kind of produce must in the main defray its own cost of production. The old-fashioned farmer was determined, at all events, to get a good crop of wheat to pay his rent with. To this end he must have a large heap of rich manure; and to supply this, a yard well filled with well-gorged fatting stock; he did not keep accounts; he could hardly tell, even approximately, how much he sacrificed in feeding each beast, or the amount of manure which it left him; and the only conclusion which he arrived at, if money ran short at the end of the year, was, that wheat could not be grown under —*s.* per bushel.

But now matters are changed; faith in the wheat crop is departed, since it has appeared, that of all our products, this least responds in price to the variations of the home supply. A new alternative for the large manure heap has arisen in guano and superphosphate, which, if applied to soils rich in minerals, and to crops which store rather than waste organic substances, will open a safer course than wasteful cattle-feeding. Indirectly, the railroads which diffuse over a larger area than formerly the straw manure made in our increasing towns contribute to check home production of manure at any cost. In the farmer's mind, the dim suspicion of loss by feeding has assumed a somewhat better defined outline, though its proportions are still very ill-determined. The return, if expected, as of old, from wheat, is at least a lottery. The risks from disease are chronic, not so much regarded as occasional and mysterious visitations of Providence, but as an abiding evil, arising more probably from want of due precautions in the transmission of our supplies of store-stock, than from the ordinary action of atmospheric influences on the more delicate constitutions of our improved breeds.

Under these circumstances, a prudent man will not risk money on cattle-feeding for the purpose of growing wheat. If he is bent on making manure, his object will possibly be, that the corn and green food consumed may go to increase his next root, rather than his corn crop; in other words, the production of

Cr.	£.	*s.*	*d.*
8 beasts sold at 22*l.* 10*s.* each	180	0	0
Loss on 8 beasts at 8*l.* 15*s.* each	70	6	8
	£250	6	8

The manure made, amounting to 165 loads, was applied to 11 acres of land, at the rate of 15 loads per acre.

meat, not corn, will have become his chief end. But this implies that the process must not only be self-supporting, but yield a profit in itself.

My conviction is strong, that assuming oil-cakes, beans, wheat, barley, &c., to retain their present values, this satisfactory result cannot be obtained even at a price of 8*s.* 6*d.* per stone of 14 lbs. on the old system of rearing stores and fatting bullocks; though on the other hand I shall endeavour to show farther on that sheep, well managed, will pay for their keep, and leave a profit under similar conditions. What then! are the powers of digestion and assimilation in the former animal essentially defective as compared with those of the latter? I should be very slow to believe this. Is then the difference of result which we arrive at due to our management being more defective in the one case than the other, and how far can we obviate this defect?

Certainly the condition of our beasts during the last period of their existence is more artificial than that of the sheep, and this is to some extent inevitable.

An adequate supply of beef cannot be obtained from those first-class pastures which will fatten an ox without any aid, together with those of the second-class, on which, with the aid of a little cake, the same result may be obtained. Pastures inferior to these are gone quite out of repute, as utterly unsuited to our improved breeds of cattle, unless it be for dairying purposes. A supplementary supply of beef then must be procured by somewhat artificial means, and the cost of producing this addition *will regulate the cost of the whole supply.* With an ulterior view to the production of corn the secondary supply was long provided at a loss; this motive has lost its chief force, and the practice will probably be discontinued: present prices do no more than represent the cost of artificial feeding according to traditionary usage, if they do as much, and therefore these prices will be maintained or advanced, unless either the consumption of beef be diminished, or science combined with careful observation and experiment teach us to conduct our necessarily artificial feeding processes with greater economy.

It is our evident duty to make the attempt, and there are several considerations which may encourage us in making it:—

1st. If we can succeed with the sheep under circumstances nearly as artificial, why may we not with the ox?

2ndly. That kind of management which, as I believe, will alone give a satisfactory result in sheep-fatting, viz., that of steady uninterrupted progressive feeding, has not been as yet *generally* applied to the ox.

3rdly. Mr. Horsfall *has* succeeded in producing beef economically, even apart from his achievements as a dairy farmer

(which latter are dependent on locality), and whatever be the secret of his success, what one man has done others may accomplish.

4thly. It being highly probable that straw-chaff will play an important part in this economical manufacture of beef, we see that recent improvements have much diminished the cost of cutting: that the attention of both scientific and practical men is actively directed to the discovery of means that will render this substance more digestible; that a slight fermentation seems conducive to this end, and more economical, whilst it is probably as efficacious as heating by steam.

5thly. The digestion of the straw itself may be promoted by the admixture of other kinds of food supplying those juices in which straw is defective as compared with grass or hay.

6thly. *Even* if this supply cannot be procured from ordinary kinds of food at fair feeding prices, attempts will not be wanting to supply the defect by medicinal compounds, which may, ere long, result in procuring us a good well-ascertained article at a moderate price.

But if, when looking to the future, we do not despair of learning to produce beef for the market at a reasonable price, without loss, or with a small profit, we have, even retrospectively, a far brighter side to our picture when we turn to our sheep. If, on the one hand, it has been an exceptional case when in past years money has not been lost by fatting beasts, on the other hand the case has been singular if, with like care bestowed, a profit has not been made by the sheep.

It may be well, however, before entering on details of the cost and profit of breeding sheep, to give some acconnt of the flock treated of, and the circumstances under which it came to be selected.

The first point which I had to decide upon when entering my farm was, whether to keep a dry or a breeding flock, or in some degree to combine the two; the next point was, which breed of sheep to prefer, though it is not easy to keep these two considerations quite separate.

My position, which was not unfavourable for a breeding flock, naturally turned my attention to that quarter; and the rearing of stock is so much the most interesting part of farming, that none but the most unfavourable circumstances will induce an old breeder to change to keeping a dry flock only.

Besides the great interest which is connected with breeding (an interest which secures attention and so conduces indirectly to profit), the following considerations influenced my decision:—

The rule that stock, if they are to thrive, should be kept steadily well from first to last, applies to the sheep as well as to the ox, yet this condition of success is not easy of attainment

when sheep have to be bought. Experience has taught us that well-bred and well-reared wether hoggets, valued at 30*s.* at Michaelmas, will pay better for fattening than the common run of older sheep bought at a venture.

Some object to a breeding flock on the ground that their land is too rich; and I have no doubt that in some cases the objection is valid; but it seems a pity that the occupiers so circumstanced, if men of capital and enterprise, do not get a slice of lean to go along with their fat land; they would not commonly have far to seek for it.

Some object that their land is too cold and wet: in such districts Mr. Bond has shown that, if the mangold and the bean-straw be turned to the best account, such difficulties may be overcome, in which case the old pastures, from which sheep and other stock have carried away so much for so long a time, may yet get a good turn in their character of dry and clean lair, without the drawback of having the heart of the herbage gnawn out as of old when sheep were wintered on them.*

But some object to a breeding flock on the ground that the poorly-fed ewe and the growing lamb extract more of the virtue out of their food than the fatting sheep. And to some extent the objection is valid; but to what extent?

First, what portion would the growing lamb extract from rich food?—next, how much less would the fatting sheep consume?—and lastly, does this difference—this fraction of a fraction—amount to more than can be compensated by the extra profit derived from lambs?

On these points practical men are left very much to grope their way in the dark, ignorant whether one-half, one-fourth, or one-eighth would most nearly represent, say, the portion of nitrogenous matter used up by a lamb when eating oilcake; whilst scientific men are wary about communicating their observations, and risking hostile criticism, until they have satisfied themselves whether such minor differences as 48·5 or 52·3, 23 or 27 per cent., as the case may be, would best represent the estimate which they have formed approximately from the imperfect means of investigation at present within their reach. It is in this respect amongst others that the Scientific Lecture renders good service,

* In October Mr. Bond's ewes range the maiden layers and stubbles, and consume the mangold tops; in November they have a piece of rape, and eat Swede tops on the old pastures; later, two roomy, well-drained, well-shedded yards are provided for 500 ewes, where they receive cut barley, oat, pea, bean, or wheat straw, besides fresh-threshed straw, in racks or between hurdles. Every day the ewes ramble over an adjoining pasture, where they receive 100 bushels of Swedes or mangolds. About a month before lambing rape-cake is added to their diet; 3 acres of cabbages are grown for the flock just before and after lambing, and bean-meal and oil-cake supplied to the lambs. In this manner 500 ewes are kept on 600 acres of cold clay-land.

by suggesting questions which elicit answers—such as would not have been hazarded in more formal statements, but nevertheless are highly serviceable, if not conclusive. No one would wish to tie Professor Voelcker rigidly down to the opinion which he was kind enough to give in reply to an inquiry, at the end of his lecture on oilcake before the Royal Agricultural Society, as to the proportion of nitrogenous matter extracted by an animal eating oilcake. His reply showed how much we were at sea on that question, whilst at the same time it suggested an hypothesis on which practical men will probably do well to act pending further information. I refer to his statement that about one quarter of the nitrogenous matter in the cake was probably extracted by the animal.*

If we assume then that the fatting sheep consumes one-fourth of the nitrogenous substances given in oilcake, and suppose that a lamb extracts say one-fourth more than the sheep, the loss of nitrogen from feeding the lamb instead of the sheep would be represented by $\frac{1}{4}$ of $\frac{1}{4}$, or 1-16th, a loss which must be estimated at the money value of the substances, not as food, but as manure; and such a loss as the profit of a good crop of lambs will appear fully to make up for. But if ewes and lambs do extract more of the goodness out of their food, on the other hand, the folding which they leave in April and May answers admirably for forcing the feed on warm, quick layers, and is turned to account probably for three successive growths before the following October; each growth being increased in consequence of the increased folding left when its predecessor was depastured, to an extent which, if the artificial food was continued, would be expressed by a geometric ratio, because each time the more feed there is the slower the fold will be moved, and the more extra food consumed on a given area: so true is it in farming, that man at times, and nature at all times, will give more to that which hath already. But, in speaking of the benefits of keeping a breeding flock, I do not mean such kind of *keeping* as makes it a hard matter for a ewe to bring up twins satisfactorily, but such as on poor land will, in a good season, give nearly 100 pairs of twins from a flock of

* When, further, the Professor seemed disposed to estimate the manuring value of the dung, as derived from the cake, as high as half the value of the cake itself, he was passing beyond the regions of pure science on to more debatable ground, on which practical men have some power of forming a judgment for themselves; and it may be doubted whether he made sufficient allowance for the difference of the value, which the same substance bears according as it is designed for food or for manure. This difference may probably be greater in the case of phosphates than of nitrogen, because we have such a cheap and ready supply of the former in the manure market; a consideration not to be overlooked when we are treating of the rearing of young stock, which draw largely on the phosphates for the formation of bone.

270 ewes, and will, consequently, leave the land each succeeding year in a better condition for growing crops of corn.

The next point to determine was the breed to be preferred; a question which soil, climate, and the tone of the neighbouring markets, go far towards deciding. Every local influence pointed towards the Down rather than the long-woolled races; but authorities were at variance as to the *kind* of Down to be selected.

It is remarkable that in Mr. Jonas Webb's immediate neighbourhood, very few tenant-farmers, except his own relations, keep a Southdown flock, and that some large proprietors who have commenced with that breed, have gradually introduced an infusion of Hampshire or Norfolk blood into their flock, till the leading characteristics have become changed.

It has been well said by one of our best modern authorities on architecture, "Use the material of the neighbourhood, and make the best of it." Believing this precept to be fully as applicable to farming as to building, I decided at least to test the local practice before I abandoned it, and commenced operations with seven score shearlings, and one score full-mouthed ewes of the black-faced half-bred Norfolk and Southdown breed (an established cross), and with three score Southdown shearlings from a flock of high repute.*

Careful attendance in the yard at lambing-time went far to determine my preference in favour of the black-faced sheep; the prices offered for the produce reared confirmed this opinion, and the experience of a second season enabled me to decide, that for my locality at least the black-faced was the best rent-paying sheep; that the Southdown ewes must be drafted to the butcher (in default of other demand for them), and the local breed improved.

The chief grounds for this decision were, 1st, The superior vigour of constitution of this race; 2ndly, The greater number of lambs which they reared *on my ground;* and 3rdly, The greater demand which prevailed for ewe lambs of this kind.

In the close competition which now exists between the different races on which sufficient care has been bestowed to secure a good fleece, early maturity, and first-rate mutton, the palm must be awarded to those ewes whose vigorous constitution makes them the best mothers and nurses, and prolongs the period of their unimpaired powers of bearing. The superiority of the black-faced breed in these respects was most marked; without any

* The Norfolks cost 37*s.* 6*d.* a-piece; the Southdowns, 45*s.* If I had wished to sell either at the end of the year, the difference in the selling price would have been in favour of the cheaper sheep; such black-faced shearlings as I then bought are now worth from 50*s.* to 55*s.*, according to the season.

protracted labour the lamb was born, the mother "took to it" directly; before long a second often followed, and the mother had licked them all over, and was on her legs feeding, before the Southdown by her side had been delivered of her young one—in many cases not without aid, and with so much pain and exhaustion that she seemed to loathe the cause of her misery. Many ewes were so set against their lambs, and their supply of milk was so defective that halters, and cow's milk, and cosseting of all kinds came into constant requisition. I speak now especially of my first year's experience; in the second year three score more shearling Downs (which had been bought as lambs) were added to the flock, and proved somewhat better mothers, though still decidedly inferior to their rivals.

The result of the first season was, that the black-faced ewes reared 189 lambs, with the loss of 2 sheep, besides supplying a good many to Southdowns which had lost their own lamb, and, with no good result, played the part of foster-mothers. The Southdowns only reared 47 lambs, with the loss of 4 of their number.

In the following season, out of 158 Norfolks, 8 died; of 112 Southdowns, 13: 230 lambs were reared in all; no record of the relative proportions of the lambs is preserved: it was a year of great losses all round the neighbourhood.

The number of lambs reared in these three last years from the black-faced flock has been:—

1858,	from 265 ewes	343 lambs.
1859,	,, 265 ,, ...	320 ,,
1860,	,, 285 ,, ...	334 ,,

The hardiness of the race, and its prolonged powers of bearing, have been tested in a manner not generally desirable, in consequence of the gap made in the flock by the large premature draft of the Southdown ewes—a gap which could not conveniently be filled up either by purchase or home-breeding—consequently twenty-five of the original seven score have been retained until this year (1860), being their tenth season; of these not one died in lambing, one was "guest," and was sold for 46*s.*, and five are bringing up ram-lambs, of which two have twins. The epitaph over one ewe which died last year was, "she owes us nothing, she has brought up sixteen lambs."

But a further most important consideration affecting the profits of a breeding flock is, that the ewe-lambs should be worth *at least as much* as the wethers: this is, moreover, an important test of the estimation in which a breed is held for stock. The best guarantee for an abiding demand for ewe-lambs is, that the stock should be in request for cross-breeding, as well as for perpetuating itself; the former demand telling more upon the

market than the latter, because some never try to breed again from the half-bred progeny, and others are dissatisfied with the results of their attempts to do so.

Whatever be the estimation in which these black-faced sheep are held as a distinct breed, their merits for cross-breeding are more widely recognised; from their largeness of frame, hardiness of constitution, and ease in parturition (no slight consideration if Cotswold or Lincoln rams are to be employed), the Downs of the east probably surpass those of the west for crossing with long-woolled rams; whilst the ram possesses in a very high degree those good qualities in which the east Down ewes are inferior, so that there is good reason to expect that the weak points in the dam will not reappear in the offspring.

At all events, the demand for black-faced ewes is steady and increasing; the ewe-lambs in a good flock are worth from 8*s.* to 10*s.* a-piece more than the wethers, whilst, if pure Southdown lambs are seen in our fairs, the wethers probably have the preference.

These observations may in some degree explain why farmers of intelligence in the eastern counties, hoping to attain early maturity and a good fleece by an infusion of new blood, cling to their old race as best adapted to a poor soil and bleak position.

The question of the flock to be kept having been decided in favour of the local breed, the next point was to recognize its existing defects, and try to remove them. These defects were in the wool, which was occasionally brown or hairy; in the chest and neck, which were narrow and thin; and in length of leg. Hampshire and Wiltshire afforded kindred races well suited to aid in effecting these improvements, but it was not easy to gain a deep chest and thick neck without the attendant broad and heavy head of some flocks, or to introduce the compact symmetry of others without losing our length of frame and superiority in size.

The able Paper on Cross-breeding, by Mr. Spooner, printed in No. xliv. of the Journal, is doubly interesting to those who have been for some years buying rams from different quarters with definite objects in view. Mr. Spooner writes:—"The most probable supposition is that each parent gives to the offspring the shape of one half of the body. Thus, the back, loins, general shape, skin, and size follow one parent; and the fore-quarters, head, vital and nervous system the other; and we may go so far as to add, that the former in the great majority of cases go with the male parent, the latter with the female."

On the other hand, the object of cross-breeding was in my case to retain the head and vital system of the dam, but to change the fore-quarters and modify the nervous system, so as to

get rid of a certain restlessness of temperament; whilst the back, loins, general shape, and skin might with advantage take after the ram, but not the size.

On contrasting this theory and these objects with the results attained, it would appear that the influence of the male was on the whole more preponderating than accorded well with either. One heavy-chested ram used but for one season left his stamp very satisfactorily impressed on the fore-quarters of nearly all his progeny. The sire's influence on the head was not marked in this instance, because ram and ewes were not dissimilar in this respect; but when other rams with peculiar heads have been used, they have influenced the head of the lambs so much, that it is an almost certain index of the pedigree on the father's side.

The Hampshire rams, again, differed much in temperament from the native race. They were sufficiently composed to come out from the ewes' fold in the morning and eat oilcake outside, and kept up their condition when the Norfolk ram would have shrunk in flesh and pined. Their stock, likewise, show a great change in temperament, being no longer restless or reluctant to be confined within yards or hurdles, and this change is naturally attended by a greater disposition to fatten at an early age.

So far, therefore, the influence of the ram seems to prevail in the nervous system of the lamb; and this was a gain in the instance under consideration; but it is questionable whether we can so distinguish between the vital and the nervous system as to hope that the old vigour of constitution may be retained unimpaired, in connexion with a modified and more placid temperament. All that influence which Mr. Spooner assigns to the sire seemed generally to be exerted in our flocks, especially with regard to size,—a merit so much esteemed in our district, that it has been necessary to return to the east for rams, and to trust to the Hampshire blood now existing in the ewes for such change of constitution as seems desirable.

Mr. Spooner observes upon the unreasonableness of rejecting a good sheep for a few spots in its face; but local feeling outstrips philosophy, and is besides sometimes built upon a true inkling which it cannot well explain, but cannot put aside. If Shropshire rams were introduced among us we might find too late that the white spots on the face were signs of a cross in the blood which had introduced a fuller habit of body and a more lymphatic temperament, favourable for early fattening, but ill suited to the climate of the bleak East.

But further attempt to penetrate the mysteries of breeding would be better adapted to a special paper on that subject, and to a writer of large and long experience in breeding. It is unfortunate that those who are best informed are, not unnaturally,

sometimes not the most inclined to publish the results of their experience.

Enough has been said regarding the breed of sheep experimented on to show how the animal may have influenced the feeding results. If these results are deemed satisfactory, the sheep may gain some credit as rent-paying stock; but if the latter are held to be decidedly of no merit, how much greater profits might have been attained by animals of really good quality? Let us, then, first examine one or two experiments in sheep feeding, to contrast with those in bullock feeding, given in its earlier pages, before we proceed to the general balance-sheet of the year for the breeding and grazing flocks. These experiments had a special design when recorded besides that of showing a profit: they may now serve a double purpose.

The first experiment stated will go back to the year 1853, a date antecedent to the great impulse given to agricultural and other prices: it stands recorded at the "time's prices," which have been left unaltered. Its immediate object was to test the comparative fattening qualities of rape and of linseed cake.

Two lots of black-faced hoggetts, consisting of 10 each, were placed in adjoining pens, partly under a shed and partly extending into an open yard beyond, on the 15th of February.

Both lots received as much of sliced swedes as they would eat (they eat 15 or 16 lbs. per head a day), but the first lot had in addition 7 lbs. a day of rape-cake, the second 7 lbs. of linseed-cake.

They were weighed on the 18th of February when they came into the pen, and again on the 25th of March, when those on rape-cake were found to have gained 61 lbs.; those on linseed 85 lbs.

As the weather became warmer, it was so evident that the hoggets on rape-cake were not thriving, that, on the 22nd of March, their food was changed, and they were again weighed, and showed a gain on the aggregate of the ten of 5 lbs. since the last weighing, but 3 of the best sheep had lost weight. These were now put on to linseed like the others, and were again weighed with the other lot on the 12th of April, when they were found to have gained 90 lbs. in 3 weeks since their change of diet, whilst the other lot had gained 91 lbs. in the course of the second month.

It thus appeared that, allowing for the difference of price between rape and linseed cakes, the linseed hoggets answered the best even during the first month; whilst there were strong indications that if the experiment had been persisted in, the wool would have been sacrificed and but little flesh gained, from the heating nature of the rape, which the sheep at last would not eat up clean.

The debtor and creditor account for the first month may be thus stated :—

Rape Cake.

First Lot.	Cost of Food for One Month. £. s. d.
Rape-cake, 1¾ cwt., at 6*s*. 6*d*.	0 11 5
Turnips, 2 tons, at 6*s*.	0 12 0
	£1 3 5
Per contra :—	
Gain in live weight 61 lbs.; in meat, 36 lbs.;* at 4 or 4½ stone, at 5*s*.	1 2 6
Loss	£0 0 11

Linseed Cake.

Second Lot.	Cost of Food.
Linseed, 1¾ cwt., at 9*s*.	0 15 9
Turnips, 2 tons, at 6*s*.	0 12 0
	£1 7 9
Per contra :—	
Gain in live weight, 85 lbs.; in meat, 50 lbs.;* or 6 stone 2 lbs., at 5*s*.	1 11 3
Profit	£0 3 6

The following tables will show the increase of the sheep, and give the financial result of the whole time of feeding in the shed.

The individual sheep were as far as possible identified; but in some cases the marks on them became obliterated, and nothing was left to guide us but the attendant's power of distinguishing them.

1853.—10 Hoggets on Rape Cake till March 22nd, and on Linseed Cake to April 26th.

No. of Sheep.	Weight Feb. 15.	Weight. Mar. 15.	In-crease.	Weight Mar. 22.	In-crease.	Weight April 12.	In-crease.	Weight April 26.	In-crease.	Total Increase.
	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.
1	120	130	10	133	3	140	7	136	−4	16
2	114	118	4	117	−1	127	10	135	8	21
3	111	117	6	116	−1	127	11	133	6	22
4	101	111	10	109	−2	118	9	124	6	23
5	99	108	9	108	0	114	6	127	13	28
6	99	102	3	104	2	114	10	127	13	28
7	97	102	5	104	2	113	9	120	7	23
8	97	102	5	103	1	113	10	118	5	21
9	96	100	4	102	2	112	10	115	3	19
10	94	99	5	98	−1	106	8	112	6	18
Totals	1028	1089	61	1094	5	1184	90	1247	63	219

* Rather more than $\frac{8}{14}$ of the live weight.

Food.

	£.	s.	d.
Rape-cake, 5 weeks, 3½ stone, 6*l.* 10*s.* per ton	0	14	3
Linseed-cake, 3 weeks 1 day, 9*l.* per ton	1	0	3
Turnips, ½ ton per week, at 6*s.* per ton	1	10	6
Value of Lambs, Feb. 15, 35*s.*	17	10	0
	20	15	0
Price, April 27, 50*s.*	25	0	0
Profit*	4	5	0

1853.—10 Hoggets on Linseed Cake.

No. of Sheep.	Weighed Feb. 15.	Weighed March 15.	Increase.	Weighed April 12.	Increase.	Total Increase.
1	123	135	12	144	9	21
2	109	122	13	133	11	24
3	107	116	9	128	12	21
4	107	116	9	123	7	16
5	106	114	8	119	5	13
6	105	112	7	124	12	19
7	104	110	6	119	9	15
8	98	108	10	116	8	18
9	97	102	5	111	9	14
10	94	100	6	109	9	15
Totals. .	1050	1135	85	1226	91	176

Food.

	£.	s.	d.
Linseed-cake, 7 lbs. per day, 65 days, at 9*l.* per ton ..	1	17	0
Swede turnips, 15 or 16 lbs. a-piece per day, say 10 cwt. per week, 9⅓ weeks, at 6*s.* per ton	1	8	0
10 Hoggets at 35*s.*	17	10	0
Cost	20	15	0
Sold, April 21st	25	0	0
Profit	4	5	0

One good result followed from the experiment being prolonged after the rape-cake was abandoned, namely, when Lot 1 was put to linseed-cake, and immediately began to show a larger increase of weight than the other lot, it became at once manifest that the bad success attending the use of the rape-cake was in no way due to the animals which had been experimented upon.

The immediate object of the next experiments was to decide upon the expediency of rearing half-bred lambs, the ewes being

* If the 5 tons of turnips consumed be valued at 8*s.* instead of 6*s.* per ton, their cost will be increased, and the profit consequently diminished by 10*s.* in each instance.

crossed with a Leicester ram. With this design a ram was bought of Mr. Powlett in 1853 and put to the inferior Norfolk ewes, that inferiority being often in point of colour, not of size, and consequently a matter of fancy. The question to determine was whether the cross-bred would have so much the advantage in wool, and in early maturity, and weight for the butcher, as to compensate for the diminished value of the ewe-hogget, which would be no longer in request for breeding purposes. The decision was against the cross-breeding: because although the gain in meat during the process of fatting was considerable, still the growth during the winter was less vigorous, and the value ultimately attained not greater. The effect on the wool was disappointing, amounting only to the difference between 58½ lbs. and 60 lbs. on 10 fleeces in one year, and that between 66 lbs. and 69 lbs. on 11 fleeces in the next: a difference which the improvement since made in the wool of the black-faced breed would quite efface, as our ewe-hoggets now average 7 lbs. throughout in a good season, and selected fleeces weigh 9, 10, and 11 lbs. apiece.

To determine these points, in February, 1854, one lot of 10 black-faced and a second lot of 10 half-bred Leicester and black-faced hoggets were put into two pens and fed alike on swedes and linseed-cake for 2 months and 11 days. At the commencement the first lot weighed 62 lbs. more than the second; at the end 8 lbs. less. The butcher reported that the dead weight of the former 10 was 652 lbs., that of the latter 668 lbs.; showing a difference of 16 lbs. in dead weight, corresponding to one of 8 lbs. in the live weight, and all this in spite of one of the second lot being ill, without which drawback the aggregate weight of the second lot would probably have been increased by 20 lbs.

In the following season, 1854-55, the comparison between the half-bred Leicester and the Norfolk was renewed. The selected lots were weighed in July and September, that any variations in the earlier growth and development of the two breeds might be noted, and an eleventh supernumerary hogget was added to each lot to guard against accidents. Every sheep, however, throve well, so that the trial was in this respect thoroughly satisfactory, for the lots were very level and the progress very uniform.

It is to be remarked that lot 2—that with Leicester blood—weighed 8 lbs. more than lot 1 in July; but in September the scale had turned by 10 lbs. in favour of lot 1. At midwinter this had increased to 57 lbs. in favour of the hardier sheep; but again, by the 15th of May, under the fatting process and in a milder season, the advantage of lot 1 had diminished to 15 lbs. The two lots, when sold, were considered by the butcher to be of equal value: lot 1 the turn heavier, but lot 2 rather more

ripe. Further experience, therefore, told rather in favour of the black-faced sheep, which had started with no advantage, gained more in winter than they lost in spring, sold as well, and left within 3 lbs. as much wool as the other breed. Each lot made 50*s.* a head out of the wool; the average weight, reckoning the percentage of meat in 100 lbs. of live weight at 54 lbs., would be nearly 79 lbs. at the end of the experiment, or a little over 10 stone at the time of sale, after a fortnight's run at grass, on which the sheep did not thrive. The season was not so favourable for sale as some, but still the debtor and creditor account shows a gain of 3*l.* 18*s.*, or nearly 3*s.* 6*d.* per head; but the turnips were only charged at the "time's price" of 3*d.* per week. If they had been charged at 4*d.* per head, the profit would have been reduced by 1*l.* 18*s.* 6*d.*

A careful examination in this season of the result of feeding hoggets, classed according to their size and forwardness, led me to adopt a practice (which I have since continued) of selling my cull lambs for the market price, and holding the best. We have seen that—

	Loss. £. *s.* *d.*	Gain. £. *s.* *d.*
22 picked wethers showed a gain of	.. ..	3 16 0
The next best 40, with 2 deaths, showed a loss of	0 7 0	.. ..
The next best 40 a gain of	.. ..	3 6 8
The next best 25 ,, ...	.. ..	0 0 0
The next best 22 a loss of	4 8 8	.. ..

Moreover, four more deaths occurred, which cannot be exactly assigned to the several lots; but undoubtedly they fell chiefly, if not exclusively, on the two weakest classes.

It will be seen that in 1854 the butcher reported the dead weights of the 22 experimental sheep; he was doubtless impartial between the two breeds experimented on. His report is, I believe, trustworthy in other respects, though he probably did not weigh until just before cutting up the carcase.

The ewe-hoggets were always weighed at 11 A.M.; by this time they were full of food, which will account for the proportion of meat, at 15 months of age, not exceeding 54 per cent.

The question remains, what proportion did the meat bear to the total live weight when fatting commenced, say in January? I regret that I have no data for a correct reply, and cannot say whether 48 or 50 per cent. would most nearly represent the true ratio; yet upon this point must depend the total gain of meat during the process of fatting.

With these explanatory observations it is hoped that the following tables will be intelligible.

TABLE I.—Showing the Live Weights of 10 Black-faced Wether Hoggets at the dates stated below, with Rate of Increase and Weight when Dead.—1854.

	Feb. 14.	March 14.	Increase.	April 11.	Increase.	Fasted and Shorn; April 22.	Increase.	Dead Weight.	Per-centage of Meat.
	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	
Lot 1.	123	134	11	142	8	142	..	78	54
	116	121	5	132	11	135	3	71	52
	109	118	9	132	14	126	6	67	53
	105	114	9	125	11	122	3	67	54
	104	113	9	125	12	122	3	65	53
	104	113	9	120	7	120	..	63	52
	103	111	8	118	7	117	1	61	52
	103	107	4	115	8	116	1	66	56
	96	106	10	113	7	113	..	55	49
	94	101	7	112	11	112	..	59	52
Total weight	1057	1138	(81)	1234	(96)	1225 Wool 58½	17	652 Average	10)527 52

The same for a Lot of 10 Cross-bred Leicester and Norfolk Wethers.—1854.

	Feb. 14.	March 14.	Increase.	April 11.	Increase.	Fasted and Shorn; April 22.	Increase.	Dead Weight.	Per-centage of Meat.
	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	
Lot 2.	110	122	12	132	10	132	..	72	54·5
	108	118	10	131	13	132	1	72	54·5
	104	118	14	129	11	132	3	72	54·5
	101	116	15	128	12	130	2	67	51·5
	98	116	18	128	12	127	−1	70	55·1
	98	115	17	128	13	125	−3	69	55·0
	98	112	14	126	14	124	−2	68	55·2
	94	110	16	123	13	121	−2	68	56·2
	93	103	10	117	14	116	−1	60	51·7
	91	(Ill) 102	11	(Ill) 106	4	(Ill) 94	−12	50	53·2
Total weight	995	1132	(137)	1248	(116)	1233 Wool 60	(−15)	668 Average	541·4 54·14

Table II.—Showing the Weights of 11 Black-faced Wether Hoggets at the stated intervals.—1854 & 1855.

	July 11.	Sept. 21.	Jan. 19.	Feb. 16.	March 16.	April 13.	Fasted and Shorn; April 17.	May 15.	Increase from Jan. 19 to May 15.
	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.
	96	99	126	136	138	159	142	168	42
	89	97	120	130	137	159	141	161	41
	88	94	115	127	131	155	140	158	43
	88	94	112	122	130	144	131	150	38
	85	93	111	121	129	143	130	147	36
Lot 1.	84	90	110	118	127	140	127	145	35
	80	88	107	114	121	139	127	141	34
	80	88	103	112	119	139	126	140	37
	79	83	101	111	116	133	122	135	34
	79	83	100	106	114	128	113	132	32
	78	80	94	104	109	128	112	130	36
Total weight	926	989	1199	1301	1371	1567	1411 Besides wool.	1607	Total increase 408
	..	926	989	1199	1301	1371		1567	
Increase	..	63	210	102	70	196		40	
Average weight	84	90	109	118·3	124·6	142·4	128	Besides wool 66	Average increase 37

The same for a Lot of 11 Down and Leicester Hoggets at the stated intervals. —1854 and 1855.

	July 11.	Sept. 21.	Jan. 19.	Feb. 16.	March 16.	April 13.*	Fasted and Shorn; April 17.	May 15.	Increase from Jan. 19 to May 15.
	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.
	95	95	115	130	142	156	139	162	47
	89	95	110	122	132	144	130	146	36
	88	93	108	117	127	142	126	146	38
	85	90	107	117	125	141	125	145	38
	85	89	105	117	125	141	125	145	40
Lot 2.	84	89	105	116	124	140	125	144	39
	84	89	104	115	123	139	124	143	39
	82	87	102	113	123	137	122	142	40
	82	86	99	112	121	137	120	140	41
	81	84	94	111	119	136	120	140	46
	80	82	93	107	117	135	119	139	46
Total weight	935	979	1142	1277	1378	1551	1375	1592	450 Besides wool.
	..	935	979	1142	1277	1378	..	1551	
Increase	..	44	163	135	101	173	..	41	
							Besides wool	69	

* I was not present at this weighing, and doubt its accuracy.

TABLE III.—Estimate of the Cost of Feeding 22 Hoggets, 11 Black-faced, and 11 half-bred Norfolk and Leicesters in 1854-1855.

1854.	£.	s.	d.
Value of 22 hoggets at Michaelmas, at 31*s*. per head ..	34	2	0
Keep to Jan. 1, 1855, at 3*s*. 9*d*. per head	4	8	0
16 lbs. per day of linseed cake, at 10 guineas per ton, for 13 weeks	6	16	6
22 lbs. per day ditto, at 11*l*. per ton, for 8 weeks	6	12	0
Turnips for 21 weeks, at 3*d*. per head per week	5	15	6
Cost of keep until the end of the experiment	57	14	0
To 2 weeks' keep at grass with linseed cake	1	14	0
	59	8	0

Per Contra.

	£.	s.	d.
Price of sheep	55	0	0
Wool, 4 tod 23 lbs. at 34*s*.	8	4	0
	63	4	0

	£.	s.	d.
Total receipts	63	4	0
Cost	59	8	0
Profit	3	16	0

I now come to the general account of the cost of the breeding and dry flocks, and of the profit made on them respectively.

And, 1st, of the breeding-flock.

For the purpose of comparison, I shall again avail myself of the calculation made by Mr. Bond for his flock of 500 ewes, as given in the description before alluded to. Mr. Bond states that he has seen reason to substitute Hampshire for Southdown ewes; that his practice is annually to buy 2 and 3 shear sheep of this description, which will rear lambs for three or four seasons, and then, as he states, to fatten them as crones up to the value of from 44*s*. to 54*s*. per head. His estimate of cost is as below, the food being charged at cost price :—

	£.	s.	d.
Attendance	40	0	0
Autumn quarter, 3*s*. per week per score ..	48	15	0
Winter quarter, 5*s*. ,, ,, ..	81	5	0
Spring quarter, 15*s*. ,, ,, ..	243	15	0
Summer quarter, 10*s*. ,, ,, ..	162	10	0
Interest	50	0	0
Loss	50	0	0
Tups	60	0	0
	736	5	0

Per Contra.

	£.	s.	d.
Produce—			
1857—600 lambs (at about 29*s.* 6*d.*)	884	0	0
Wool, 61 tods	144	0	0
Total	1028	0	0
Cost	736	5	0
Profit	291	15	0

	£.	s.	d.
1858—650 lambs, 60 tods of wool	970	0	0
Cost	736	5	0
Profit	233	15	0

This statement (as well as the details of management and the arguments which it sums up) is generally so correct that on most points it may be adopted as the basis of our calculations; but one item seems either undercharged on the one side or over-estimated on the other. It is calculated that the crones—now 6 shear sheep—after bearing 3 or 4 lambs on the farm, are to be sold fat at the same price at which they were originally bought, towards the end of the summer quarter. During this quarter (which may be taken to occupy the time from the middle of May to the middle of August), only 10*s.* per score, or 6*d.* per head, is allowed for both ewe and lamb (or lambs). Of this sum nearly 4*d.* would be required for the keep of the lamb, leaving 2*d.* for that of the ewe: quite enough to keep it in a store condition, but not to prepare it for the butcher. Between one-third and one-fourth of this flock of 500 ewes is drafted annually; so that, making due allowance for deaths, fully 6 score crones will have to be fatted and an extra cost incurred, which in *my* case would not fall short of the following item:—

	£.	s.	d.
For cost of extra keep of 6 score crones, for 13 weeks, at 10s. per score	39	0	0

Mr. Bond's pastures, however, may enable him to realise this result more economically than I could do.*

The charge for the spring quarter (from the middle of February to the middle of May) of 15*s.*, or 9*d.* per head per week, seems ample.

Two verifications of this are appended, applying to crops of turnips on very weak soils.

* It may also be observed that Mr. Bond makes no allowance for expenses of washing, dressing, shearing, and sales, for which in my case 20*l.* will be charged.

1859, March 19th—Cost of Keep of a Ewe Flock, 13 score.

Cost per Week.	£.	s.	d.
2 acres of white turnips (a poor crop), at 2*l.* or 3⅗*d.* per head	4	0	0
Malt-combs, 1 sack per day	1	11	6
Wheat chaff, 5 fans per day *	0	11	3
	6	2	9
Meal, malt-combs, and bran, for lambs, 4 stone per day, at 1*s.* per stone	1	8	0
	7	10	9

(Per score, 11*s.* 7*d.* nearly.)

Later in the season, when the flock was removed on to some of the poorest land in cultivation, the account stood thus:—

Cost per Week.		£.	s.	d.
4½ acres of turnips, 3⅗*d.* per head		4	0	0
7 cwt. of oil cake	70*s.* 0*d.*			
Charged to the land ⅓	23 0			
	47 0			
Charged to flock		2	7	0
Malt-combs, 2 bushels per day		0	15	9
Wheat chaff, as above		0	11	3
Lambs' food, 4 stone, as above		1	8	0
		9	2	0

(Per score, 14*s.*)

In this case the inferior quality of the roots called for an extra supply of artificial food, which was given as much for the sake of the land as of the flock, and hence the deduction made. It will be observed, however, that we have still the margin between 14*s.* per score of expenditure and Mr. Bond's estimate of 15*s.*

Or again, the following statement will fairly represent the total cost in one spring quarter:—

Artificial Food.

	£.	s.	d.
4 weeks, 1 cwt. of rape cake per day, 28 cwt. at 7*s.* (nearly)	10	0	0
4 weeks, 4 bushels of beans per day, at 4*s.* 6*d.*	25	4	0
5 weeks, 2 bushels of beans per day	15	15	0
13	50	19	0

Average of artificial food per week $\frac{50l.\ 19s.}{13} = 3l.\ 17s.\ 6d.$

	s.	d.
* Cost of cutting by hand 35 fans, at 3*s.* per score	5	3
Loss on the straw, 12 cwt. at 6*d.*	6	0
(An outside estimate)		
	11	3

As the season advanced less straw chaff would be consumed, and the saving effected would furnish increased supplies of meal for the growing lambs.

Cost per week in Spring Quarter.

	£.	s.	d.
Average cost of corn or cake	3	17	6
Turnips	4	0	0
Cut chaff (average) *	0	7	6
4 stone of meal, &c., for lambs	1	8	0
Average cost per week	9	13	0

Or within 2*s.* of the estimated cost for 13 score ewes at 15*s.*, viz. 9*l.* 15*s.*

Having thus to a certain extent substantiated Mr. Bond's estimate as a very liberal allowance for keep in the spring quarter, I will adopt his rate of charge for the three other quarters and compare my own balance-sheet with his. But I must first explain that I keep 265 ewes, breed all my own, selecting the best for my own use and valuing them at 10*s.* per head above the price made of the remainder when sold. We reckon the average value of the ewes kept to be 55*s.*; this year (1860) they are worth 65*s.* They will breed 7 lambs, and be better mothers to the last than to the first of these; they are then worth about 26*s.* as crones. The flock has been estimated at an average value of 45*s.* per head. The cost of rams is very variable. Sometimes we give 20 or 25 guineas for a lamb which does us hardly any service; sometimes we buy one for 10 guineas, which stands us in good stead for three seasons. The actual cost incurred for rams bought, hired, and bred during the last four years was 195*l.* 5*s.* The average loss of ewes is estimated at 10 a season, worth 45*s.* a head. More have been lost by a supply of over-succulent food after lambing than in the lambing-yard.

The losses for these last six years, as well after as before weaning, have been:—1854, 6 + 3 = 9; 1855, 11 + 2 = 13; 1856, 7; 1857, 7 + 1 = 8; 1858, 18; 1859, 15; giving an average of over 11 a year, which excess is due to want of caution in 1858.

About 50 lambs are left as ram-lambs, involving an extra cost for keep amounting to 10*s.* per head; part are sold at the end of July, and all on sale are disposed of by the beginning of September. The old rams sold, together with the fleeces, pay for the keep of all the rams.

The following is then my calculation of expenses:—

* Varying from 10*s.*, as above, to 5*s.*, according to the coldness of the weather.

	£.	s.	d.
Attendance	40	0	0
Keep of 13 score ewes, autumn quarter, at 3*s.* per score	25	7	0
,, ,, winter quarter, at 5*s.* per score ..	42	5	0
,, ,, spring quarter, at 15*s.* per score	126	15	0
,, ,, summer quarter, at 10*s.* per score	84	10	0
Extra keep for 50 ram lambs, at 10*s.*	25	0	0
Interest on 650*l.* (ewes 600*l.*, rams 50*l.*)	26	0	0
Loss, 10 ewes at 45*s.*	22	10	0
Rams	50	0	0
Draft of 45 shearlings, at 55*s.*	123	15	0
Expenses of sales, washing, shearing, and dressing ..	20	0	0
	586	2	0

On the other side of the account we have in 1858 :—

		£.	s.	d.
39	ram lambs sold	188	10	0
2	ditto kept	15	0	0
17	fat lambs sold	35	14	0
90	cull lambs sold	103	10	0
195	lambs kept as hoggets, at 35*s.*, and accounted for in the next year	341	5	0
	Crones, 31 at 22*s.**	34	2	0
	Ewes' wool, 40 tod 13 lbs., at 29*s.*	58	13	0
343	Total of lambs.—Total receipts	776	14	0
	Expenses	586	2	0
	Profit	190	12	0

In 1859.

		£.	s.	d.
43	ram lambs sold	171	10	0
2	ditto kept	16	0	0
9	fat lambs	15	15	0
65	cull lambs sold	71	10	0
201	store lambs kept, at 35*s.*..	351	15	0
	Ewes' wool, 37 tod, at 39*s.*	72	3	0
	Crones (say) 30, at 25*s.*†	37	10	0
320	Total No. of lambs.—Total receipts	736	3	0
	Expenses	586	2	0
	Profit..	150	1	0

Mr. Bond's gain of 291*l.* 15*s.* in 1857, and 233*l.* 15*s.* in 1858, shows an average profit at the rate of nearly 22 per cent. on 1200*l.* of live stock. The above statements, on the other hand, show an average price of $24\frac{3}{4}$ per cent. on a capital of

* Sold early in the quarter, so that their keep is charged in excess.

† An unusual number of crones were drafted in this year ; but as on the other side of payments the draft of ewes is taken *on an average*, the entry for receipts from crones must be adjusted accordingly.

650*l.*, with larger allowance made for the cost of replacing the ewes and other contingent expenses.

I now come to the other branch of sheep-farming,—that of preparing wethers for the butcher or shearling ewes for the flock. About 200 lambs are held over the winter, at an average value of 35*s.* a-piece, or 350*l.* for 200 lambs. Nearly 120 of these are ewe-hoggets, the remaining 80, wethers, such as are left after the 50 best male lambs have been selected as rams. The ewe lambs are the more valuable. If 38*s.* 6*d.* be the price put on 120 ewe-hoggets and 30*s.* on the 80 wethers, the aggregate value will be 351*l.* instead of 350*l.*, and the comparative worth of the two classes fairly represented. Both lots live together until the end of January, and are kept in *good* store condition for the sake of the staple of the wool as well as for the growth of the young sheep. If they live entirely on turnips, they probably consume 1½ cwt. of bulbs per head per week (besides leaves and stalks), or at the rate of 22 lbs. per day (we have seen that in a yard, with two-thirds of a pound of cake, hoggets ate 16 lbs. of turnips). If artificial food were given, this consumption would decrease. If we value the turnips at 6*s.* 8*d.* per ton, 1½ cwt. would cost 6*d.* per week, a sum much higher than the customary price of the neighbourhood warrants, even for swedes when consumed on the spot. Such a value, therefore, can only be regarded as new or theoretic, adapted to the present times, when roots are no longer to be subsidiary to corn, but to pay their own way. As the season advances, however, the hoggets receive nearly half a pound of rape-cake per day, which may be considered to increase the cost of their keep by 2*d.* a week.

If, however, we take a comprehensive view of the 20 weeks, beginning from Michaelmas, during which the ewe and wether hoggets are together, we may fairly balance the earlier weeks, in which rape and white turnips are eaten at a cost of 4*d.*, against the later weeks, when swedes and rape-cake cost 8*d.* a head per week, and consider 6*d.* a week as an ample average estimate of keep throughout the entire period.

Besides the cost of keep, losses by death and other small expenses should be allowed for. I find that the losses from 1856 to 1859 inclusive were 9, 4, 6, 5 respectively, and the average sum received for the damaged stock about 2*l.* If 6 be taken as the average number of deaths, and 2*l.* as the price of each lamb lost, 12*l.* will be the value of the lambs, from which 2*l.* may be deducted for sale of skins and carcases, leaving a loss of 10*l.*, or of 1*s.* per head on 200 hoggets. Dressing the hoggets will cost 1*l.* 10*s.*, washing and shearing 2*l.* 10*s.*; a charge of 5*d.* per head will cover these expenses.

The cost of keeping the ewe-hoggets from the time of parting

to Lady-Day may be estimated at 6*d.* per head per week; from that time till the end of July (when they are sold or put into the flock), 4*d.* per head.

The wethers are fatted on richer food and sold in the course of May.

It will be expedient to make out a separate debtor and creditor account for ewes and wethers, which will be drawn up on the same basis as those already given, but more briefly stated on account of the length to which this paper has run.

Such being a general scheme of the cost of the dry flock, we may test its accuracy by rendering a distinct account for special seasons. In 1858 no minute records of changes of food were preserved; the season was not very favourable, and, as will be seen, a good price being set upon the turnips and contingent expenses allowed for, no profit was made. The account of the wether and ewe hoggets is kept distinct, that each may tell its own tale; the fatting sheep being most beneficial to the farm if the direct return made by them be nearly equal to that derived from the ewes.

1858.—*Debtor and Creditor Account of* 190 *Hoggets.*

Michaelmas, 1857.

	£.	s.	d.	£.	s.	d.
Valuation of 190 hoggets, at 35*s.* per head	..			332	10	0
62 wethers, at 30*s.*	93	0	0			
122 ewes, at 38*s.*	231	16	0			
6 losses by death	7	14	0			
				332	10	0

Payments.

	£.	s.	d.	£.	s.	d.
Cost of 62 wether hoggets, at 1*l.* 10*s.*				93	0	0
Keep of 62 wethers, per head, per week, &c.:—						
20 weeks, at 6*d.*	£0	10	0			
12 weeks, at 8*d.*	0	8	0			
Share of losses	0	1	0			
Expenses, shearing, dressing, &c. ..	0	0	5			
Attendance	0	1	7			
Total keep of 62 wethers at	1	1	0 =	65	2	0
Total payments				158	2	0

Receipts.

	£.	s.	d.	£.	s.	d.
For 62 wethers, sold at 43*s.*	£133	6	0			
For wool, at (nearly) 7*s.* 5*d.* per head	23	0	0			
				156	6	0
Loss				1	16	0

Payments on account of Ewe Hoggets.

	£.	s.	d.	£.	s.	d.
122 ewe hoggets, at 38*s.*				231	16	0
Keep of 122 ewe hoggets, per head, per week, &c. :—						
26 weeks, at 6*d.*	£0	13	0			
12 ditto, at 4*d.*	0	4	0			
Share of losses	0	1	0			
Expenses, shearing, &c.	0	0	5			
Attendance	0	1	7			
Keep of 122 ewes, at	1	0	0 =	122	0	0
Total payments				353	16	0

Receipts.

	£.	s.	d.	£.	s.	d.
For 70 inferior ewes, sold at 46*s.* ..	161	0	0			
For 50 picked ewes, at 56*s.*	140	0	0			
	301	0	0			
Wool, at (nearly) 7*s.* 6*d.* per head ..	45	11	0			
Total receipts				346	11	0
Loss				7	5	0

	£.	s.	d.
No. of hoggets, 6.			
Losses by death, balance of valuation	7	14	0
Allowed for keep, 5*s.* per head	1	10	0
	9	4	0
Allowance for losses, 1*s.* per head on 184 hoggets	9	4	0
Received for damaged stock	3	12	0
	12	16	0
Deduct	9	4	0
Excess of allowance	3	12	0

	£.	s.	d.
Loss on wethers	1	16	0
Ditto on ewes	7	5	0
	9	1	0
Excess of allowance for losses	3	12	0
Total loss	5	9	0

Wool.

	£.	s.	d.	£.	s.	d.
Wethers	23	0	0			
Ewes	45	11	0			
				68	11	0
Received for 43 tod 15 lbs. at 31*s.* 6*d.* cash				68	11	0

Cost of Wether Hoggets—1859.

	£.	s.	d.
59 lambs, at 30s.	88	10	0
19 weeks' keep, at 6d. for 59 hoggets	28	0	6
5 weeks, with ½ lb of cake, at 8d., for ditto ..	9	17	0
4 weeks, with 1 lb. of cake, at 10d.	9	17	0
Share of losses, at 1s. per head	2	19	0
Share of expenses for dressing	1	4	6
Attendance	5	0	0
Total payments	145	8	0

Receipts.

	£.	s.	d.
For 59 sheep, at 46s.	135	14	0
For wool, 59 fleeces at 8s. 6d.	25	1	6
	160	15	6
Expenses	145	8	0
Profits on wethers	15	7	6
(or 5s. per head.)			

Cost of Ewe Hoggets.

	£.	s.	d.
129 ewe hoggets, at 38s.	245	2	0
26 weeks' keep, at 6d., 129 ewes	83	17	0
16 weeks' ditto, at 4d.	34	8	0
Share of losses, at 1s. per head	6	9	0
Share of expenses	2	13	9
Attendance (besides the shepherd)	10	0	0
	382	9	9

Receipts.

	£.	s.	d.
Price of 50 ewes, at 47s. 6d.	118	15	0
,, 79 ,, 57s. 6d.	227	2	6
Wool (the balance) 8s. 6d., nearly	56	0	0
	401	17	6
Cost	382	9	9
Profit	19	7	9

(or 3s. per head.)

The following is a brief recapitulation of the points which it has been the object of this paper to establish:—

1st. That bullocks purchased lean for the purpose of fatting leave a greater deficit in the balance-sheet than the worth of the manure made will compensate, when corn is at present prices.

2nd. That bullocks may be steadily and economically reared and fed so as to avoid a loss, and gain the benefit of the manure.

3rd. That a ewe flock leaves a good profit when well managed, with a liberal allowance made for keep at received rates.

4th. That a dry flock may be kept without loss, or with a moderate profit, according to the season, if the turnips consumed be valued at 6*s*. 8*d*. per ton.

XV.—*On the Modifications of the Four-course Rotation, which Modern Improvements have rendered advisable.* By P. Debell Tuckett.

The object of a rotation of crops is two-fold. 1st. To alternate with the narrow-leaved cereals those plants which, from their producing a large surface of foliage, are especially fitted to extract from the air the carbon, oxygen, and hydrogen, needed for the formation of the organic portions of all our crops. 2dly. By recurring to the same crop only at more or less extended intervals, to avoid the exhaustion of those various inorganic matters in the soil which are required by our crops in very different proportions, and for the supply of which we have to trust partly to the soil itself, and partly to the manures which we apply to it.

The Norfolk four-course rotation, as originally introduced, consisted of—

In the first year	Turnips.
„ second year	Barley.
„ third year	Clover.
„ fourth year	Wheat.

and nothing could be better adapted to the first of the above objects. The broad leaves of the turnip and the rich foliage of the red clover, obtain from the air a vast quantity of vegetable matter, which, if the crops are consumed on the land, or returned to it in the shape of manure, remains for the production of succeeding crops.

But experience has proved that a greater variety of cropping is desirable, and that one, if not more, of those crops cannot be successfully grown so often as once in every four years.

In considering the modifications that are thus rendered advisable, it is proposed first, to notice such variations of the four-course shift, as retain its main feature—a fallow or root-crop once in four years; and afterwards to proceed to other courses, such as the five and six course rotations.

The great difficulty in the Norfolk four-course rotation, is the failure of the clover plant. If sown every four years, especially on light soils, the land becomes clover-sick, and the clover misses plant. Hence the first and now universal modification,

is the partial substitution of other crops in the third year of the course, so as only to repeat the red clover once in eight or even sixteen years.

In many counties it is usual to sow a mixture of white clover and trefoil for feeding, with half the spring corn; and often one or two pecks of English or Italian ryegrass are added to increase the feed. This addition cannot be recommended; for, though the quantity of keep is considerably increased, it is dearly paid for by the damage done, especially by the Italian variety, to the succeeding wheat crop; a fact which I have not only repeatedly observed myself, but which I find to be admitted by farmers in almost all parts of the country; and I believe that the admixture of ryegrass is rapidly decreasing in the best-farmed districts.* If grown at all, it is far better to sow Italian ryegrass as a distinct crop.

Various reasons are assigned for this failure of wheat after ryegrass; but, without discarding all other causes, I think there can be no doubt that ryegrass is too nearly allied to the wheat plant to be a good preparation for it.

But even, without ryegrass, we can reckon upon a better crop of wheat after mown clover, than after grazed seeds; and many agriculturists consider a better one still after clover twice mown. This fact, though generally admitted, is at first sight somewhat anomalous; but it appears to be explained by the large amount of roots formed by red clover, when allowed to stand for hay. White clover and trefoil would not, of course, under any circumstances, produce so much either feed or root as a good plant of red clover; but keeping the plant constantly fed down from spring to autumn, must naturally check its development under ground. If, as has been stated as the result of experiment, the weight of roots per acre is more than doubled by letting the clover stand for a second crop, we have an amount of vegetable matter, principally derived from the air, which forms a valuable dressing for the following crop of wheat, though it cannot, of course, supply the place of the *inorganic* substances carried away in the hay crop.

* Necessity has compelled me to sow rye-grass largely and repeatedly on soils too light and poor to grow clovers with any certainty; but hitherto I have had no cause for regret. Under the management adopted the land has improved in the production both of corn and of green crops. The rye-grass is always folded off by sheep in hurdles and is stocked early, as soon as it begins to flower. With these precautions no evil results need be apprehended from this crop. In a moist season on a burning soil its produce will far exceed that of any other plant; whilst the thick bed of roots which it leaves behind is of essential service in improving the mechanical condition of such a soil for the following corn crop. The evil influence of this crop depends on its seed being allowed to ripen, a process so rapidly performed as often to take the farmer by surprise. On the same soils all attempts to grow rye as a green crop, whether for mowing or folding off, were attended with evidently injurious effects on the following corn crop.—P. H. F.

From the above considerations I am inclined to think that considerable benefit would result from allowing clover or seeds to stand till they have made considerable growth, and then folding them off like rape or any similar green crop. I am aware that in a backward spring this would be apt to try the patience of the flockmaster; but, especially on light soils, where shading the land in summer is an advantage, I should expect an increase both of feed and of vegetable matter left in the soil as the result.*

The trifolium incarnatum may sometimes be advantageously substituted for clover. I have found it very useful, when clover has missed plant, sowing it on stubble after harvest, and harrowing and rolling it in. It yields a large crop of rather coarse hay.

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* I entirely concur with the author in the opinion here expressed. The use of hurdles and a fold has enabled me much to increase my stock, and yet to dispense with hiring feed; whilst in the late hot summers my sheep have had an abundance of keep, when some of my neighbours' fields were nearly as bare as a fallow.

When we once admit the advantage of letting a crop grow unchecked till it is fit for the scythe, for the sake of the ulterior benefit which may be derived from the full development of the root (independent of that of the blade, as in this case the land is robbed of the upper growth), the advantage to be gained from allowing the plant to attain maturity in cases where the upper growth is likewise to be turned to account upon the spot as dung, can never be gainsayed. There is no special virtue in the scythe's edge; the stumps of plants left by the sheep's tooth will be quite as favourably circumstanced for renewed growth as if they had been mown, if only judgment be shown in regulating the fold according to the weather, so as to eat off the feed just "to the right pitch."

The reason of the benefit derived from allowing the plant freely to develope itself is obvious. Each leaf that expands is a new mouth—it is a feeder as well as food. A store of leaves is to the plant its stock-in-trade; the closely-gnawed root struggles on like an insolvent tradesman, who is never allowed to acquire capital, and consequently can never thrive; whilst, to the freely-growing plant, the more it has, the more is added, until it attains its full growth and is ready for the process of fructification, from which point its constitution begins to deteriorate for the purpose of food.

The only drawback or limit to the use of the fold arises from the fact—1st. That lambs dislike restraint. 2ndly. That it is distasteful to them to fold the same ground a second or third time.

It may, however, be observed on the 1st point that lambs of the improved breeds are not nearly so restless as the older races, and are more easily trained to bear restraint; and, on the 2nd, that where summer-soiling with green food is carried on, as well as a good breadth of land reserved for hay, it will not be hard so to shift the lambs' feeding-ground that they shall not have to go twice over the same piece. The field first fed may be afterwards cut for soiling, whilst that mown for hay will provide after-feed for the lambs. Experience will soon show whether the after-growth springs most freely after the scythe or a properly-regulated fold. It is probably not wise to combat the natural repugnance of the lamb to feed after the fold; for this instinct may be a safeguard against evil influences, too subtle for our philosophy in its present state. The mortality which in some districts has of late carried off many of the older lambs has been attributed to want of attention to this warning, nor can any more plausible reason be assigned for the loss. The degree, however, to which the surface of the land is tainted probably varies according as the soil is wet and tenacious or dry and porous. On sandy soils lambs may be folded twice without injury; and the older sheep, being less dainty and more hardy, may generally follow where the lambs have fed before.—P. H. F.

Sainfoin to stand for one year only has been substituted by Mr. Coleman for clover on the light sands and chalks of the Earl of Leicester's farm, at Holkham, and he assures me with very satisfactory results. He recommends sowing one-third of the spring corn with clover, one-third with trefoil and sainfoin in place of ryegrass, and one-third with sainfoin alone, taking care that the clover follows the sainfoin in the succeeding course. It has hitherto proved almost impossible, on these remarkably light sands, to insure a crop of clover; but by this change the difficulty appears to be to a great extent overcome. The red clover is found to stand much better, and although the sainfoin seed costs about 30*s.* per acre, Mr. Coleman finds he can invariably grow more feed than will cover the extra expense. The quantity of seed used is four bushels per acre in the husk. Mr. Coleman has sown it on barley in April or May, rolling the ground previously, so as to insure a firm seed-bed, which is very important, and only just covering it with soil.

On clay soils beans or peas may be advantageously alternated with clover, taking in the third year:—

One-fourth ..	..	Red clover for mowing.
One-fourth ...	..	Seeds.
Two-fourths ..	..	Beans or peas.

This course is very commonly adopted on the stiffer soils of Buckinghamshire, the eastern counties, and many other districts. It is true that the bean crop is not a very paying one, taking into account its expense and uncertainty, but it leaves the land in a much cleaner state than clover; and on mixed arable and pasture farms on clay soils, where winter food is scarcer than summer keep, I think the general experience is in favour of this course.

On the farm of that justly celebrated agriculturist, Mr. Hudson, of Castle Acre, I have seen a crop of peas followed by turnips. The peas were Mintoe's Early Grey; they were cut at the end of July, when not quite ripe, and laid out on an adjoining clover ley to ripen; and by the employment of a large strength of horses, the field of 16 acres was manured, ploughed, and sown with turnips the next day.

I have alluded first to the modifications in the third year of the four-course shift, because it is in that part of the rotation that they have been most extensively introduced; but it is not only the clover crop that needs a change.

It does not fall within the province of this report to discuss the causes of the extensive destruction of the turnip crop, whether by fly, fingers and toes, or mildew; but I think that the great increase of these diseases in those districts that have long grown

turnips, does suggest the desirability of cultivating a *variety* of green and root crops.

There can be no doubt that, with our improved implements, autumn cultivation and artificial manures, a crop of turnips may be *grown* on any land, however stiff, provided it has first been thoroughly drained; but the damage sometimes done in wet seasons by the treading of sheep in feeding off, or by the carts and horses, when the crop is drawn, seems at present to limit the breadth that can be profitably cultivated on such soils.

Both rape and tares are extensively substituted for a portion of the turnip-crop, and on many soils with decided benefit. The former can generally be fed off before the land has become very wet, whilst early sown vetches afford a most valuable supply of green food, either for mowing or folding, after the turnips are consumed, at a time of year when keep is often very scarce.

I observe that the cultivation of mangold wurzel is steadily increasing throughout the country. It produces a greater weight per acre than any other of our root-crops; and, according to the analyses published by Professor Johnston, contains about 15 per cent. of solid matter, whilst the turnip contains only about 12 per cent. It is true that from being sown a month earlier than swedes, mangold requires an extra hoeing; and that the fact of its not bearing frost entails an additional expense in getting it in; but against this may be set its exemption from fingers and toes and mildew; and on deep soils, where the treading of sheep is not beneficial, it will be found desirable to grow as much as can be readily drawn off and secured before the early frosts.

On chalk and limestone soils, white mustard is not an unusual green crop. I have found it very useful for late autumn keep, sowing it as an extra crop on a wheat stubble, which may be raised by a Bentall or scarifier. Many persons recommend ploughing it in as a preparation for turnips, but experience on this point is very conflicting. In some cases great benefit has resulted to the succeeding crop, whilst in others there has been no perceptible difference. I am inclined to think that the effect of a green crop ploughed in, depends very much upon the amount of vegetable matter which the soil contains at the time,* and that on most soils feeding off is the most economical plan.

By turning to account the choice afforded between the foregoing and other crops, and by ploughing up and cleaning as

* The mechanical effect must not be overlooked. In this respect, a green crop ploughed in will exert a greater influence, whether for good or harm, than a dressing of fresh farmyard-manure. A good result may be anticipated on stiff soils if mustard is ploughed in in the autumn, and barley sown the following spring; whereas, if wheat sowing follows immediately on the ploughing, frost may injure the wheat-plant in consequence of the open state of the land.—P. H. F.

much of the wheat-stubble as possible in autumn, so as in fact to constitute a winter-fallow, the necessity for bare summer-fallows is almost removed.

Still, on thoroughly heavy soils, there will be cases where a field is very foul, or the season adverse, when, unless steam-cultivation come to our aid, we must be content to go without a crop.

As regards the white straw-crops in the four-course shift, the chief alteration requiring notice is the substitution of wheat for a part of the barley or oat crop. And if land be in good condition, and prices offer a sufficient inducement, there is no reason why wheat should not, at any rate on moderately heavy soils, be grown after such of the root and green crops as are cleared off early enough to admit of its being sown in good season.

Mangold wurzel is now almost universally followed by wheat; and out of some hundreds of farms, in various counties, on which I have had opportunity for ascertaining the point, I could refer to but very few on which the breadth under wheat has not of late years considerably exceeded that of barley and oats together.* It is very observable that the proportion sown with wheat has extended during the last five or ten years, but, doubtless, present prices will somewhat check this tendency.

Some farmers, and good ones too, take a crop of oats or barley after the wheat-crop, thus forming a five-course rotation; but on the class of soils which will best bear this addition to the white straw-crops, few farmers will wish to increase the breadth in barley and oats at the expense of that in wheat, which is, to a certain extent, the effect of this change, whilst on stock farms the loss of green and root-crops will be felt as a disadvantage.

On land, where barley is apt to become coarse, a better sample is obtained by thus sowing it on a wheat etch; and so important is this considered in Hampshire, that it is there not uncommon to take the crop of barley immediately after the wheat in the four-course rotation, and to follow the clover with the root-crop.

In the neighbourhood of a town and railway station in Essex, where special facilities exist for procuring manure and food, I have seen the above five-course rotation carried out with apparent

* It is very important for us to ascertain to what extent the wheat-plant, with its penetrating root and protracted period of growth, exhausts the soil more than barley. In the case of wheat, Mr. Lawes' experiments indicate a great defect in the amount of nitrogen removed in the crop, and remaining in the soil after harvest, as compared with that supplied to the soil for the growth of the crop. What account can be given of this deficiency, except that these elements have been used up by the plant in its long battle with an inclement season, as well as in the processes of flowering and ripening the seed, which are common to both wheat and barley? An experiment, recording the comparative results arising from the alternation of wheat on the one hand and barley on the other, with a green crop, for a series of years on the same land, might do good service to agriculture.—P. H. F.

advantage, and the land kept in high condition and very clean; but in ordinary agricultural localities I have observed that it is seldom persevered in to the full extent of the farm.

No doubt the four-course shift is often followed from necessity, being required by the terms of the agreement on which the farm is held; but I find that in the case of several large estates, embracing a great variety of soils, where this five-course is permitted, scarcely any of the tenants avail themselves of it, except to a very limited extent, though they make full use of their privilege of growing beans in place of a portion of the clover.

Still I think it very good policy, on the part of landlords, to give tenants the option of pursuing this system, by permitting three-fifths of the arable land to be in white straw-crops. The more liberty there is given, the more inducement there will be to good farmers to lay out money in improvements, whilst the restriction even of a five-course shift will be sufficient to act as a check upon bad ones; and it should always be borne in mind that neither agreements nor stringent covenants as to cropping can ever convert a bad farmer into a good one.

It is scarcely necessary to allude to the five-course rotation, which is followed in some hilly districts, and on thin poor soils, where the clover is allowed to stand for two years, as this is a system which modern improvements, by lessening the difficulty and expense of cultivation, are rendering less and less necessary.

The six-course rotation, so common in Scotland, has of late years considerably extended in this country; and there is reason to believe that it would be adopted still more frequently if farmers were unrestricted by their agreements.

In this case we have :—

In the first year	.. ..	Turnips or other root-crops.
„ second „	.. ..	Barley or oats.
„ third „	.. ..	Clover or seeds.
„ fourth „	.. ..	Wheat.
„ fifth „	.. ..	Beans, peas, potatoes, &c.
„ sixth „	.. ..	Wheat.

I have had opportunities of observing this system, as pursued on a lias clay in Leicestershire, and also on a mixed soil in Gloucestershire, and it appears to me to offer several advantages on moderately heavy soils, especially on those mixed arable and pasture farms, where the root-crop does not form so important an item in the farmer's calculations as it does on the lighter soils. The risk of failure in the turnip and clover crops is diminished by their recurrence only once in 6 years. The reduced breadth of turnip or fallow land will generally prevent the necessity for bare-fallowing, even on stiff soils, provided that the bean-crop is

kept properly clean; whilst the breadth in wheat is increased to one-third of the arable land.

On light turnip-soils any diminution of the proportion of fallow-crops will probably prove unprofitable; but it cannot be denied that clay-soils, if kept clean, are capable of producing more than one crop of wheat in four years, with turnips, barley, and clover between.

In illustration of this, I may refer to an experiment made in Lincolnshire by a thoroughly good farmer, who usually adheres to the four-course shift. In the year 1850 he broke up 10 acres of inferior grass-land on the lias clay, and took 7 crops in succession, viz.:—

In 1850	Oats.	In 1854	Beans.
,, 1851	Oats.	,, 1855	Wheat.
,, 1852	Wheat.	,, 1856	Barley.
,, 1853	Wheat.		

The only manure applied was a moderate dressing of dung for the beans in 1854. All the crops, with the exception of the first, were good. I was present when the seventh—the barley of 1856—was dressed up, and found the produce of the 10 acres to be 55½ quarters of tolerably fair quality. The field was by no means foul, though it was then fallowed.

This also shows how much may be produced by poor, cold, clay, grass-land, if broken up—land that, whilst it remains in grass, is scarcely worth any rent at all. I should, however, be the last to recommend such an excess of cropping as the above, which must, of course, end in leaving the newly broken-up land no better than that which has been under the plough for many years.

The capability of clay-soils to grow a crop of wheat oftener than once in four years is also strikingly proved by the Rev. S. Smith's Lois Weedon Husbandry, where a crop of wheat is grown every year, the air and soil being the only sources of manure; for, however sceptical we may be as to the profit derivable from this system, there is no doubt of the fact that moderately-good crops of wheat have been grown for a number of years successively.*

In the north of Lincolnshire, on the heavy clays in the neighbourhood of the town of Brigg, and on the Carrs of the Ancholme Level, I have met with two or three peculiar rotations, which come under the head of six-course rotations. These deserve a passing notice, although they are hardly likely to be adopted in other districts.

* But in this case, as in the last-named instance of successive corn crops, the wheat was grown on land lately broken up from pasture, and that not of inferior quality.—P. H. F.

On the clay-soils the rotation is—

1st year	Rape or turnips.	4th year	Clover ley.
2nd „	Oats or wheat.	5th „	Oats.
3rd „	Clover.	6th „	Wheat.

On the peaty-soil of the Carrs—

1st year	Rape or turnips.	4th year	Clover.
2nd „	Oats.	5th „	Clover ley.
3rd „	Wheat.	6th „	Half oats, half wheat.

Or,

6th year	Oats.
7th „	Wheat.

The first of these rotations is adopted from the great expense and uncertainty attending the turnip-crop on such heavy soils, the breadth being thereby diminished to one-sixth; whilst, on the black peaty soil of the Carrs, the liability to "fingers and toes" prevents turnips or rape from being sown so often as once in four years, and on this land clover is apt to be smothered if sown with the first corn-crop.

On one clay-farm in the same district I found the following rotation pursued:—

1st year	Turnips; fallow.	6th year	Wheat.
2nd „	Barley; wheat.	7th „	Turnips.
3rd „	Seeds.	8th „	Barley.
4th „	2nd year's seeds.	9th „	Red Clover.
5th „	Oats.	10th „	Wheat.

The small additional quantity of feed obtained from the seeds is certainly not a sufficient reason for growing oats *before* wheat in the fifth year of this course.*

The foregoing are some of the deviations from the four-course system that have come within my own experience or observation, and I have endeavoured to point out, as briefly as possible, what appear to me to be their principal advantages and disadvantages.

Amidst all the diversities of soil and climate, and the various other circumstances that operate on our choice of crops, it would be idle to lay down a universal rule; but I think we may venture to conclude that on light soils, adapted for sheep, it will be generally expedient to follow the main features of the four-course system, with such variations as may prevent the too frequent recurrence of the same crops; whilst on clay-soils the choice will probably lie between a modified four-course and a six-course rotation.

* The extra feed may be the chief inducement on the lands in question; but with the moist climate and low temperature of some districts wheat following immediately after two years' seeds runs too much to straw.—P. H. F.

33, *Holford Square, London, February,* 1859.

XVI.—*Report upon the Past and Present State of the Agriculture of the Danish Monarchy; its Products, with Comparative Tables of Exports.* By HARRY RAINALS, British Vice-Consul, Copenhagen. May, 1860. Published with the sanction of the Foreign Office.

DENMARK is essentially an agricultural country; the surface of the soil offers few impediments to cultivation, and, as the kingdom and the duchies are alike devoid of mineral wealth and have but few factories, the rural population is almost excluded from other occupation than that of agriculture; but, if the source of prosperity of the Danes is chiefly confined to husbandry, that vocation is nevertheless varied by the cultivation of grain and plants, by the dairy, the breeding of horses, the fatting of cattle, &c.

Among the causes on which agricultural prosperity depends, there are scarcely any of greater importance than the climate and the geology of a country.

The climate of Denmark is, in this respect, more favourable than might be expected from its northern situation. In consequence of the flatness of the country, its western position, and extent of sea-coast, the mean annual temperature is higher than in many more southern countries: it is 6·58° Réaumur, while that of Berlin is 6·79°, that of Dantzic 6·31°, and that of Berne 6·19°. There are countries enjoying a higher mean temperature where, in consequence of severe frost, no grain can be produced. But that which in this country more especially advances agriculture is the favourable relation between the climate of winter and that of summer. The winter commences late, and is generally not very rigorous; thus the laburnum and the walnut-tree grow luxuriantly here, while they are frequently destroyed by frost in Prussia and in Mecklenburg, and the vine can uncovered resist the cold better than in the most northerly vine countries, though, in consequence of the greater heat in spring and autumn, its fruit is more likely to come to maturity there than here. While Denmark has no frost which prevents the thriving of many trees and plants, its summer sun is so powerful that it ripens those fruits which do not come to maturity in milder climates. Thus Edinburgh, which is situated in the same latitude as Copenhagen, has a mean temperature of 7·11° Réaumur, while the latter has only 6·58°, and the average temperature of winter in Edinburgh is 3° higher than at Copenhagen; nevertheless, peaches seldom ripen in Scotland, while they constantly do so here.

Nearly all the corn and fodder crops of central and northern Germany can be produced in this country with little or no risk; the quantity of rain which falls during the year (calculated at a depth of 20 inches), in conjunction with a suitable degree of warmth, favours the growth of pasture. If more rain fell, a large proportion of the rich clayey-soil of the country could not be cultivated. The time of the principal rainfall is also advantageous; thus, it rains least in March and April—the time for ploughing, harrowing, and sowing,—and most between May and October, when its influence on the growth of corn and grass is most beneficial.

Denmark is generally free from continuous drought or heavy falls of rain, nor is she much exposed to hailstorms, so destructive in mountainous regions; but, as the time of harvest draws near, heavy storms frequently damage the grain and frustrate the hopes of the farmer.

Though the severity of the winter is not great, still, as a general rule, field-labour is suspended from the latter part of November until the commencement of March; but in this respect there is great variety in different districts. The light sandy soil can be ploughed during the winter, provided it is free from snow or ice, and the well-drained fields may be worked a week later in the winter and a fortnight earlier in the spring than other lands. In the south of Denmark field-labour may generally be continued fourteen days longer than in the north.

The result of this interruption of work is an increased activity in ploughing during the autumn, and still more in spring, so much so that these periods are frequently busier than even the time of harvest; but, for the same reason, more time and attention can be given to the thrashing and winnowing of corn, and similar work, during the winter months.

The Danish farmer is obliged to lay in a larger stock of winter fodder than is necessary in most other countries; as a general rule, all cattle are stabled in the middle of October, and the grazing can scarcely be said to commence until the latter part of May; sheep are generally stall-fed from the latter part of November to the close of April.

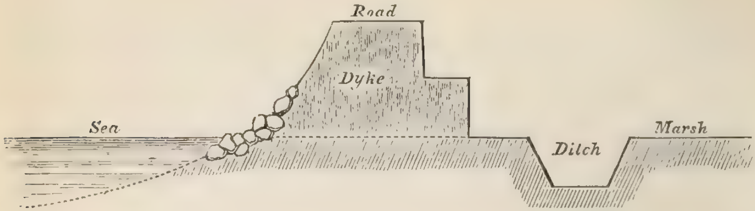
The geological condition of Denmark offers few impediments to agriculture. Rocks do not interfere with tillage, except on some parts of the island of Bornholm. Cultivation is not checked by great elevations, except on the "Himmelberg" in Jutland, which has an altitude of 550 feet; but in other respects the surface of Denmark offers so much variety in soil that the mode of culture in one district entirely differs from that of another. Along the

west coast and in central Jutland the soil is very sandy; on the east coast sands and clay-loams prevail; on the islands of Funen and Sealand, clay-loams; and on the islands of Lolland and Falster, stiffer clays: in many parts, especially in Jutland, are found considerable tracts of heath, moss, and bog. One of the latter, measuring about 22 English square miles, called the "Vild-Mose," and situated in the north-west of Jutland, it is now proposed to drain and cultivate. In some districts the marl reaches the surface; in most places it is so near that it can be used as a fertiliser without great difficulty or expense. A great many rivulets or inlets of the sea intersect the country, and the meadows on their borders are extremely rich.

The formation of territory on the west coast of Sleswig and Holstein, which may be regarded as the gift of the sea, deserves special notice. Every sea that rolls from the ocean towards the west coast of Sleswig and Holstein holds in suspension some fine particles of sand and clay, which are readily deposited when the waves approach the shore and lose their force in consequence of the shallows; this operation is assisted by the presence of numerous small islands, against which the waves are broken. From this clayey slime (called "Slik") the marshes are formed. The deposit brought by each tide is extremely small; fifty years are often required to form a foot of soil, but there are cases where a much shorter period has sufficed—for instance, during the great ice-floe of 1839, when in one night the deposit was 8 inches deep near Husum. To assist the action of the waves, the inhabitants have thrown out low dams just under water, which prevent the deposits from being again carried to sea by the ebb. These dams are constructed of poles, branches of trees, straw, and clay. Nature, too, has rendered assistance by assigning to the sandbanks a peculiar plant, called the "Queller" (*Salicornea herbacea*), without leaves, but with horizontally shooting arms, which impede the flow of the water and become a kind of embankment for the collection of these clayey deposits. In this manner the margin of the ocean rises in the course of time so much above water that it is inundated only during spring-tide. Nature then supplies this land with an unusually fine and plentiful herbage, after which it is called "Foreland," and is chiefly used for the grazing of sheep. When a sufficient "Foreland" is formed, the construction of dykes commences. The highest spring-tide known was that of 1825, which rose 19 feet above highwater-mark; to guard against such a risk, the dykes in Sleswig vary in height from 22 to 24 feet; in Eiderstedt and Holstein from 30 to 40 feet.

The new dykes are substantially built, with the side towards

the sea sloping, so as to break the force of the waves. The section below represents their outline.



On the first 12 feet there is only a rise of 1 foot; higher up this rise increases to 1 in 6 or 1 in 4 feet. The top, from 16 to 18 feet wide, is called the "Crown," and serves as a highway. Towards the land they are steep, and built with terraces for the sake of strength. The earth for their construction is taken from pits, which must, however, not be close at hand, lest they should weaken the foundation. The dykes are generally covered with grass-turf, and are placed at some distance from the sea, that they may not be exposed to its continuous action. Where this precaution is not observed the slope must be paved, but, as stones must be brought from Norway, this is a most expensive process. Already in the twelfth and thirteenth centuries dykes existed, but they were small and badly constructed. The largest number was built in the sixteenth century. They begin at Hoyer, in the north of Sleswig, and stretch as far as "Wedel," near Altona, a distance of 188 English miles.

A piece of land thus embanked is called a "Koug," and the total area they cover exceeds 900 English square miles. Within the last eighteen months something like 12,000 acres of land, near Hoyer, in Sleswig, have in this way been rescued from the sea and cultivated; it is supposed that eighty years ago this tract of land formed part of the ocean. In the course of time new deposits have formed a fresh foreland, and new dykes have been constructed outside the old ones, and thus land has continued to be wrested from the sea to such an extent that some of the oldest dykes are situated at a distance of 9 English miles from the coast. Those in the marshes, no longer necessary as a protection against the sea, are yet indispensable as highways, it being impossible to make roads on the marsh-land level, because it is frequently inundated from the interior of the country. The marsh-land being flat, with but a trifling elevation above the sea, the water from the high-land of the interior finds no natural outlet. Self-acting sluices are therefore constructed, which close as the tide rises and open again as it falls, the double gates opening

towards the sea as soon as the exterior pressure of the tide is withdrawn. When, however, the tide has for some time been higher than usual, the water in the marshes thus headed back collects in such quantities as to flood the level in a way that would be destructive to any roads there constructed. Cottages are built in the marshes on artificial hills, or sometimes even on the terraces of the dykes; round them a few trees may be seen, but otherwise the marshes are treeless; even hedges do not exist, but the fields are separated by ditches. To cross these ditches the inhabitants of the marshes (both male and female) avail themselves of leaping-poles 8 feet long.

It appears singular that such gigantic undertakings as the dams, the dykes, the locks, &c., should pay, but yet the fact is established. The marshes of the duchies of Sleswig and Holstein are considered some of the most fertile districts in the world; grass, corn, rape-seed, and beans thrive there with extraordinary luxuriance; while a cow, as a general rule, gives but 8 to 10 quarts of milk daily, those in the marshes give 20 to 30; while oats and barley in good soil give 12 to 14-fold, they yield 30 to 42-fold in the marshes. I may name Mr. Erslev, the eminent writer on the National Economy of Denmark, as my authority for these statements.

Some remarkable features are presented by the small islands called "Halligerne" on the west coast of Sleswig, at a distance from the marshes of from 5 to 30 English miles. They are generally inhabited, but cannot be cultivated, as they are frequently inundated at high water. The houses, or cabins, are therefore built on artificial mounds formed 20 feet high, called "wharfs";—at spring-tide, however, the water frequently penetrates into the houses, and the inhabitants must then escape to the lofts, where they sometimes remain several days surrounded by the ocean. The loft, or roof, does not rest on the house, but upon strong poles driven down into the earth; it sometimes happens that the walls of the house are washed away, whilst the inhabitants remain in safety under the roof, but at times they are unfortunately drowned. They are a tough and hardy people, who, strange to say, love their impoverished islands too well to be induced to remove elsewhere by the promise of prosperity. These people belong to the Frisian race, and never marry out of it. They are neither farmers nor fishermen, but shepherds; 100 sheep suffice to support an ordinary family. To the houses on the "wharfs" are attached enclosed grounds, where the sheep seek shelter at very high water; but, nevertheless, many of them are drowned. By the side of each house is found a cistern, where rain-water is collected; it is the sole water-reservoir of the inhabitants of these singular islands.

The Danish monarchy contains at present (1860) of—

	English Square Miles.
Arable land	14,520
Heaths	3,256
Mosses and bog-meadows	1,606
Woods	1,012
Marsh-land	880
Lakes	330
Shifting sand	286
Total	21,890

Although the prosperity of agriculture in a country greatly depends upon its commerce, and Denmark cannot lay claim to be considered a commercial country as the term is usually understood, the farmer nevertheless finds ready sale for his produce, either directly to the consumer, or, through an agent, to the merchant. As the rural population is about four-fold larger than that of the towns, the direct sale to consumers must of course be of comparatively small importance, the more so as the inhabitants of the provincial towns frequently possess sufficient land to supply themselves with corn for breadstuffs, and, when this is not the case, they obtain their grain from the corn-dealer, or purchase bread from the baker. They do, indeed, usually buy their butter, cheese, eggs, and in part their meat, direct from the small farmers, but are generally supplied with produce of very inferior quality. For instance, the butter, or the article sold in the market by the yeomen-farmers under that name, is execrably bad ; it is strongly salted with the commonest salt, whilst in its preparation so little regard is paid to the proper extraction of the whey, or even to cleanliness, that it appears strange that such produce can find a sale ; but the consumption of butter in Denmark is extremely large, amounting, on an average, to from 28 to 30 lbs. per head per annum, so that greater importance is attached to quantity than to quality. The higher classes are supplied by the proprietors of the larger estates with a superior article ; this is especially the case with those who supply the markets of the capital and Hamburg, and still more so with those who wish to find a market in England. The same rule applies to cattle : the worst are sent to provincial towns, the better to Copenhagen, the next best to Hamburg, and the best to England.

But, though the home consumption is by no means small, it will be seen that very considerable exports of grain, cattle, and provisions take place under very favourable conditions. The provincial towns seldom lie more than from 16 to 20 English

miles from each other, and, where the distance is greater, dealers settle in the country to purchase the produce from the farmer, or take it in exchange for other goods.

Thus, the farmer will seldom be at a greater distance than 8 or 12 English miles from the nearest market and place of shipment; it is true that the farthest point from the sea is about 32 miles, but nearly everywhere the land is intersected by bays or inlets from the sea, which are navigable for small vessels far up the country, and considerably facilitate communication and exportation.

These harbours and places of shipment, combined with excellent roads, as improved within ten or twenty years, go far to account for the non-existence of railways in Jutland up to the present moment. One line is, however, now to be established, the importance of which for the agriculture of that province may be viewed apart from its value as an investment.

Before the meeting of the late Diet the Government had granted the concession of a line of railway to Sir Morton Peto, which has now been commenced. This line is from Aarhuus to Braband, thence to Randers, Langaa, Viborg, Skive, and Struer; it will, however, probably not be carried beyond Skive. During the Session of the Diet two other lines were proposed; one from Randers, along the rivulet "Gudenaa," to Tange, with a branch to Viborg, thence to Linaa and Rye, with a branch to Aarhuus, and a prospect of an extension in the direction of Flensburg, whence a railway already runs to Altona. This line had the support of the majority of the Diet, but was opposed and rejected by Government.

The other or, as it is called, the "East Coast" line was to have this direction, viz.—from Aarhuus to Braband, thence to Langaa, with a branch to Viborg, Randers, and Hobro: the projectors of this line proposed to extend it northward to Fredeckshavn, and southward to Fredericia, in conjunction with a contemplated line through the island of Funen. The minority of the Diet voted for this line, and it was rejected. The main opposition to the first or "Gudenaa" line seems to have arisen from a fear of placing Jutland in direct railway connexion with Hamburg, whereby its trade would be carried to that place instead of to the Danish islands; the objection to the "East Coast" line is that it favours the richer part of the province at the expense of the more barren, and will not advance the interest of the province at large.

Neither line can perhaps be expected to pay until the network of railways is more complete, and especially until it is placed in direct communication either with Hamburg or some port on the west coast of Sleswig which could serve

as a place of shipment direct to Great Britain. Upon examining the question, it has appeared to me that if the "Gudenaa" or even the "East Coast" line of railway were extended to Ballum (on the west coast of Sleswig), and a harbour were built there, a considerable direct trade with England must be the consequence, and prove of very great advantage to both countries, at the same time that the politico-commercial question of too close intercourse with Hamburg or Germany would be evaded. I have been told that it would be difficult to build a harbour at Ballum, in consequence of want of depth of water; but this I doubt: if, however, this should prove the case, then a dyke, like those along the marshes, might during ebb-tides be built from the coast of Sleswig across to the island of Romo (distant 8½ English miles), with a railway from the mainland to the centre of the island, and thence to its south-east part, where its natural bend would materially assist in the formation of a harbour. No doubt this would be an expensive undertaking, but I think it could not fail to prove remunerative in the course of time.

The attention of the Jutland farmer would by such direct communication be drawn, even more than at present, to England as a market for his produce, especially cattle. A considerable number of cattle is already exported from Jutland *viâ* Hamburg to England, as will appear further on. One of the reasons for this indirect traffic is, that the Jutland farmer is not sufficiently acquainted with the preparing and sorting of cattle for the English market, and leaves this branch of the trade to the Hamburg dealer. A still greater number of Jutland cattle, after having been fatted in the marshes, is exported *viâ* Husum or Tonning to England. But the great drawback to this trade lies in the fact that the Jutland farmer, having no railways, is obliged to drive his lean cattle for a long distance to be fatted on the marshes, at a loss of 1*l.* 10*s.* per head; which loss would be still greater in the case of a fat ox. As soon as the Jutland farmer understands how to sort and prepare his cattle for the English market, when he has had time to form a breed that shall not be rejected there, and finally, when he can send his fat cattle by rail to a place of shipment, then a steady, direct, and profitable trade cannot fail to be established with England.

Farm-Buildings.

Generally the Danish farmer, both the large and the small proprietor, appears to have but an indifferent idea of building appropriately and cheaply, and fails to select the proper relative position for the different buildings—such as stables, granaries, barns, &c. This branch of agricultural knowledge has made the least advance, and still follows the old traditions. The buildings

are nearly always erected in a square, with the dwelling-house on the one side, the barn opposite, and on either side buildings used as stables, granaries, &c. The barns are not constructed with practical skill; too heavy timber is used, whereby much room is unnecessarily taken up, expense increased, and the grain exposed to injury from rats and mice.

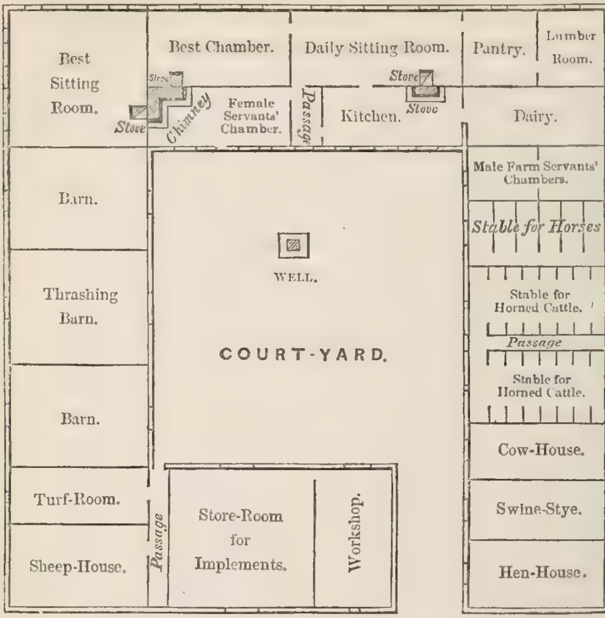
The stables are generally low, dark, and badly ventilated. The cattle are placed in two rows lengthways, with their heads towards the walls; the pavement is bad, and difficult to keep clean, as the manure is not easily removed from the deep furrows between the stones. The older buildings have in general been erected with oak framework, but those now in course of building are frequently constructed entirely of brick. The roofs are thatched either with straw or reeds.

While the farm-buildings are generally thus far defective, a great difference may yet be observed amongst them in the various parts of the country; and, strange to say, as a general rule, the worse the soil, the better the buildings. Thus central Jutland, with a sandy soil, has good buildings, while on the east coast of that province and on Sealand, with richer soil, they are but indifferent. This may be accounted for thus: in central Jutland there are no woods, and the transport of timber from the coast would be attended with great expense; consequently the buildings are erected with bricks (there being brick-kilns in most neighbourhoods); and secondly, the yeomen there have in early times been less oppressed than elsewhere, and have consequently, without risk, been more able and willing to spend money on their buildings.

The accompanying ground-plan marked **A** will give a general idea of the usual arrangement of farm-buildings in Denmark Proper. It is preferred for the protection it is supposed to afford against wind and weather. As it is there almost universally adopted, the farmers in general must accept it with all its inconveniences, one of which is certainly the absence of proper ventilation. It cannot, however, be denied that the plan has this advantage,—that the whole of the court-yard, where farm-labour is carried on, is visible from the dwelling-house. I have been informed by a competent authority that, as a general rule, the cost of the buildings on small farms is much too great, and that it often rises to one-third or one-fourth of their entire value.

The farm-buildings in Holstein are better than those in the kingdom and in Sleswig, but both in Holstein and in Sleswig the plan of such buildings varies much from that adopted in Denmark Proper. In these duchies the principal farm-buildings are under one roof, and consist of dwelling-house, barn, stables, &c. The accompanying ground-plan marked **B** will give a fair

idea on the subject. The entrance is by a very large gateway. This leads to the covered platform called "Diele," where all the

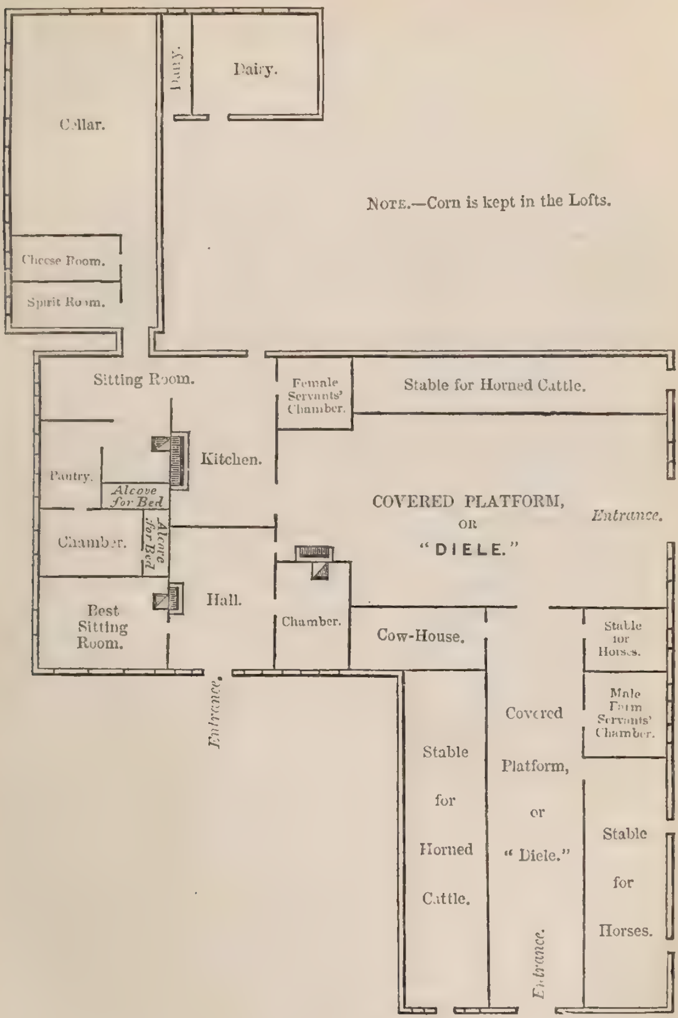


A.—Ground Plan.

Danish Yeoman Farm-House.

farm-labour takes place; here the corn is thrashed and winnowed, and the carts, ploughs, harrows, with all other farming implements, are kept and repaired. This platform suffers much from want of proper light. In the stables the cattle are placed

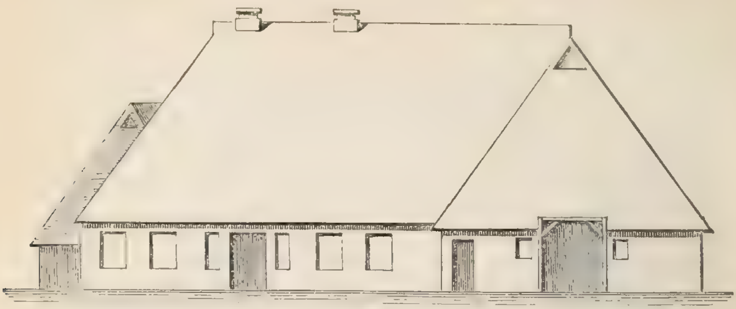
with heads towards the "Diele," from whence the food is supplied. In the old Holstein farm-buildings the fireplace in common for



B.—Ground Plan.

the whole building is found on one side of the "Diele;" in it the food for the family and labourers is cooked, it is used for brewing and baking, and for boiling fodder, when required for the cattle, and by it the dwelling-house is warmed. In both duchies a door communicates from the platform (Diele) with

the dwelling-house; in this door is always to be found a large pane of glass, which enables the farmers to observe everything going on in the "Diele."



Frontage of a Yeoman Farm-House in Holstein and in the South of Sleswig, constructed upon an improved system.

The use of stacks is the exception rather than the rule, probably from want of practical knowledge how to build them. In years of rich harvest they are to be met with, because the barns are then too confined to hold the corn; but they are so badly constructed and insufficiently protected against weather or vermin that it is generally calculated that corn from the stack will weigh two pounds less per barrel (about four bushels) than that in the barn. In Holstein, where the climate more resembles that of northern Germany, and is consequently more rigorous, stacks are still less in use.

The social condition of the people of Denmark has been much improved since a free constitution was granted in 1848. Every subject of the State now enjoys a direct influence on the affairs of the country, which has proved of great importance to the agriculturists, who, to a great extent, now have it in their power to remove those hindrances which, by earlier law, have been placed in the way of husbandry. The financial state of the country has also been made more secure, for no taxes or imposts can now be levied without the sanction of the representatives, so that it is impossible for any government, however arbitrary in other matters, to assess the population beyond its fair means of payment. The election-laws of the country seem, however, based on too extended a principle to secure to the Diet a sufficient number of members belonging to the better-educated classes.

The taxes may be thus divided:—

1. The royal taxes, required to defray the expenses of the Government in general, the defence of the country, the universities, schools, &c.

2. The county taxes: for the special expenses of the county, such as roads, schools, the salaries of the police, minor officers of justice, &c.

3. Communal taxes: to defray the cost of the minor roads, waterworks, schools, &c.

4. Tithes: levied for the support of the clergy and the maintenance of the parish churches, &c.

The kingdom of Denmark employs a very remarkable measurement called "Hartkorn," as a basis for the proper distribution of the taxes, and for ascertaining the fertility of the soil, the meaning and origin of which I will endeavour to explain. Until 1664 the nobles, the clergy, and the large landed proprietors, assessed the taxes of the yeomen (Bönder), and for such purposes used registers of lands, with their rentals (called "Land-books," or "Matrikler"), in which were entered all the different imposts—whether in corn, money, or manual labour—which the yeoman had to pay to the lord of the manor. In these registers a special column was kept in which the collected taxes of each yeoman were transformed into an equivalent quantity of rye or barley, or, as these were called, "*hard-corn*," whence the word "Hartkorn." In 1664 the Government undertook the distribution of taxes, but the said registers ("Land-books," or "Matrikler,") were taken as its basis, and this means of taxation was consequently most unsatisfactory and unjust. In 1681 another form of register was introduced, based upon the extent and quality of the lands assessed, and consequently more just in principle than its predecessor; but, as the measurement and survey were very incomplete, it failed to give satisfaction, and a new form of register (also called "Matrikel") was commenced in various districts between 1806 and 1822. This was founded on the same principle, but more correctly executed than that of 1681, and became law in 1844. The lands were first surveyed and measured with great care, and afterwards a value was put on them, or their quality stated. To settle the value or quality of land the best soil in Denmark was taken as a basis, and had the relative numerical value of 24 assigned to it; the worst soil was 0; and between these limits all the land in the kingdom was valued. Two hundred and eighty-eight thousand square feet, or about 6½ acres of land, of quality No. 24, were assessed at 1 ton (Tonde) of Hartkorn; of land with a lower number or rate of taxation, a comparatively larger area was required; for instance, of soil rated as No. 12, the quantity taken was double that of No. 24, &c.

The taxation for woods, meadows, bogs, mosses and heaths, was made, in a somewhat different manner, with reference to the

number of loads of hay which could be obtained, or the head of cattle that could be grazed on a certain area.

The term "Hartkorn," which originally signified a certain quantity of rye or barley, has thus, in the course of time, been changed to represent a certain area, together with a certain quality of land, and to designate the basis of the land-tax. The use of "Hartkorn" as a means of assessment, forms a practical medium for ascertaining the quantity and quality of land, and is of great service in fixing the value of any particular property; because when its area, its assessment in "Hartkorn," and its stock of cattle, &c., are stated, a fair idea of its value is obtained. The taxes of late years on a ton of "Hartkorn" may on an average be taken, at from 3*l.* 6*s.* 8*d.* to 3*l.* 11*s.* 1*d.*, and be thus subdivided:—Royal and county taxes, 1*l.* 7*s.*; communal taxes, 1*l.* 4*s.* 9*d.*; and tithes, 1*l.* 2*s.* 6*d.* to 1*l.* 7*s.* This makes an average of from 18*s.* to 1*l.* per individual on the whole population of the kingdom; but if to this be added the town-rates and the indirect taxes, paid both by the town and rural population, then the annual taxation of the kingdom may be calculated at 1*l.* 11*s.* 6*d.* to 1*l.* 16*s.* per head: an assessment which the general prosperity of Denmark readily admits of.

As the "Hartkorn" is a relative expression for the fertility of the soil in the kingdom, it is not without interest to state its distribution:—

			Acres of Land.		Tons of Hartkorn.
The Island of Sealand	.. ..	(with its districts) has	1,663,027,	with	113,778
,,	Funen	,,	751,747	,,	56,909
,,	Lolland and Falster	,,	375,577	,,	30,152
,,	Bornholm ..	,,	132,310	,,	6,048
The Peninsula of Jutland ..		,,	5,619,168	,,	170,973

In the islands $12\frac{1}{2}$ acres of land, in Jutland $32\frac{3}{4}$, and in the whole kingdom $21\frac{1}{4}$, are, on an average, equal to a ton of "Hartkorn."

Some idea of the extraordinary difference in the fertility of soil in various districts may be given by stating that in the north-east of Jutland about 138 acres of land are required to make 1 ton of "Hartkorn," while in the parish of Frederiksborg, 23 miles from Copenhagen, $8\frac{1}{4}$ acres suffice. The greatest average fertility in the kingdom is found on the islands of Laaland and Falster. Next come, in the order in which they are named, the south of Sealand, Funen, the north of Sealand, central part of the east coast of Jutland, its southern part, its northern part, and finally, the west coast and centre of Jutland; but the latter is so sterile that in it large tracts of land lie uncultivated. The proportion between the cultivated and uncultivated area of land in

the Danish monarchy will be seen from this comparative Table:—

	Geographical Square Miles.
Arable land and marshes	676
Heaths and quicksand	175
Moss-land and uncultivated bog-meadows	74
Woodland	49
Lakes	15
Roads, hedges, dykes, ditches, and building-grounds ..	41
Total	1030

In the duchies of Sleswig and Holstein no means of assessment or of ascertaining the value of land, like that of "Hartkorn," exist; in almost every district the local measure differs in name and content, so that it is next to impossible to give satisfactory information on this head. Here the basis of assessment is the "Plov" (plough), as "Hartkorn" in the kingdom. By a "Plov" was originally understood so much land as could be cultivated with one plough. As early as the commencement of the thirteenth century the term was used in legal enactments. It had, however, reference only to arable land under cultivation, and consequently not to woodland, heaths, bogs, &c., but when these, in the course of time, were cleared and cultivated, the value of land assessed under the head of "Plov" varied considerably. This mode of assessment underwent a revision in the years 1643-52, but only the greatest errors and injustice were thereby removed. Different properties are now frequently met with having lands of equal quality, where in the one case 150 acres, in the other 300 acres of land constitute one "Plov." It is therefore impossible to state the positive quantity of land required to make a "Plov," but on an average it may be calculated to be equal to about 14 tons of "Hartkorn," or 175 acres of land of average quality. Certain properties which, up to that time, had been free from all taxes, and were not divided into "Plove," were, by a royal decree of 31st December, 1800, ordered to be taxed, and had therefore to be so divided. On this occasion it was decided that these new "Plove" should be calculated at 125 acres of land each, and this was the first instance when a fixed quantity of land was assigned to a "Plov."

This question of measurement of land in the duchies is one that has of late been often made the subject of debate, both privately and in the provincial Diets of the duchies; part of the population of both duchies earnestly desire the introduction of a practical system, as that of "Hartkorn" in the kingdom, but, so long as the present system of election to the Diets of the duchies exists, this proposal will meet with great opposition

from the preponderating influence of the nobles and large proprietors. In Sleswig, for instance, this class, though it only numbers twenty-one voters, sends nine members to the Assembly, and, as it is for the interest of these proprietors to retain the old measurement, their party will probably oppose the introduction of any new system, however beneficial to the country at large. Those small farmers who have much improved their land, and would, by a new law, be subject to higher taxes, will also continue to oppose a change.

The Duchy of Sleswig is taxed at the rate of 19,257 "Plove," the Duchy of Holstein for 16,812 "Plove."

THE SYSTEM OF LIFE-LEASE OR FORCED LEASEHOLD (called "Fœsteforholdet"), or the relation between landlord and lessee, is a question which in Denmark has had the greatest influence on the progress of agriculture and on the condition of the smaller farmers or yeomen (Bönder). Since the constitution of 1848 was granted this question has caused much contention between the two principal political parties of the country—the supporters of the yeomen, and those of the larger proprietors.

In the earliest time, and up to the twelfth and thirteenth century, the rural population was divided into two classes, the yeomen (Bonden) and the bondmen (Trœllen). The yeomen were all on an equality; they alike took part in wars, they had votes in the election of the kings, and were entitled to be present at the "Ting," where legal trials took place, &c. In the thirteenth century, however, the foundation was laid for a greater distinction between the different inhabitants of the rural districts, inasmuch as some of them were chosen men-at-arms (Hœrmœnd), and took upon themselves to meet fully equipped for war, when called upon by the King. As a recompense the King gave them large tracts of uncultivated land, whereby the foundation of feudal estates was laid in Denmark. These proprietors became later the all-powerful feudal lords; independent of such properties the King gave them considerable privileges, which increased as the importance of these lords augmented, so that the yeomen who did not become men-at-arms or feudal lords were, to a certain extent, their subordinates.

About this period the system of Life-Lease (Fœsteforholdet) commenced. Good land, except that in the possession of the feudal lords, had now become scarce, and the waste land was not worth cultivating; it was therefore not strange if the yeomen, who had no property of their own, and the bondmen who were liberated as civilization advanced, sought to obtain a livelihood by renting or leasing land from the feudal lords. It was utterly impossible for these latter to cultivate all the large grants of land which they had received from the King, and they therefore readily leased it

to these yeomen or bondmen on condition that they cultivated and built upon it, paid an annual ground-rent (Landgilde) in corn or money, or gave a certain number of days' personal service on the proprietor's estate; this latter manorial service was at first only required when the proprietor's estate lay close to the land leased, and was later called "Hoverie" (villenage). These leases (Fœste) were for the lives of the lessee and his wife, for a term of fifty years, or for the lives of two persons named.

When a leaseholder died the land was leased on payment of a fine (Indfœstning) to another person, who, as a general rule, was a son of the deceased, or related to him.

At first this system was a mutual advantage; the lessee, though subordinate, was nevertheless almost an independent man, who could give notice to quit the property, if it did not suit him, and go where he liked; but in the course of time circumstances changed and he became less free; the "Landgilde," or ground-rent, was raised, the manorial service was increased and made more arbitrary, so much so that the yeoman was frequently called upon to work on the estate of the feudal lord at the period when his own land required most of his time and labour. In their despair these yeomen at different times sought to throw off the yoke by revolting, but these attempts were put down, and they were then more than ever oppressed, and, by the introduction of "Vornedskab" (bondage, without the right to quit their homestead), even deprived of personal liberty. The feudal lords, then, not only considered the yeoman's leasehold, but himself, as their property, and he was not permitted to leave the estate on which he was born, without the sanction of the owner and the payment of a sum of money.

The privileges of the feudal lords were enlarged, and the oppression exercised on yeomen increased to such an extent, that, in the fifteenth and sixteenth centuries, they became almost an article of merchandise—sold and bought as cattle,—whilst the few vain attempts made from time to time by the government to promote the interest of this class, failed. In the middle of the sixteenth century there were but 5000 free yeomen in Denmark, and of these the largest number, 3400, was in Jutland, where their position, in consequence of the non-existence of the "Vornedskab" there, was altogether better than on the islands. On the latter scarcely any yeoman had property of his own; thus, on the island of Sealand, only 185, and on that of Falster only 2, such were to be found.

The condition of the yeomen appeared at this period to have reached its worst point, but the following centuries proved that such had not been the case. When German princes ascended the Danish throne, Danes were supplanted at court by Germans,

and these were soon enriched by the munificent gifts of their royal master; from this period it was rare to see natives of Denmark in the councils of the King, and after a while the feudal lords were compelled to cede their large fiefs to German favourites who had been invited into the country.

If the Danish noblemen had to some extent oppressed the yeoman, yet instances were not wanting where they protected him against oppression from without; but the foreigners felt no such sympathy. The obligation to remain on the estate of his birth (Stavnsbaandet), and the villenage (Hoverie), were the chief means employed by the German nobility to subjugate the yeoman.

The "Vornedskab," by which the yeoman was deprived of the liberty of removal from the estate on which he was born, had long existed on Sealand, Lolland, and Falster, and the surrounding minor islands, and continued until the eighteenth century. In 1702 Frederick IV. did away with this obligation with respect to all yeomen or their descendants born since his accession, 1699. All farm-servants from Jutland, or elsewhere where "Vornedskab" had not been introduced, were at liberty to settle free from "Vornedskab" where it existed; the lords of the manors were forbidden to sell their bondmen, but these could purchase their own freedom at a price not to exceed 5*l.* 10*s.* The beneficial effect of the royal clemency was already apparent when, twenty-two years later, a sudden change took place in the King's principles of government, and induced him to issue the law of "Stavnsbaand," similar to "Vornedskab," but applicable to the whole of the kingdom save the island of Bornholm. In 1724 a royal decree was issued, in accordance with which all males from the age of 14 to 35 were bound to remain on the estate to which they belonged, and this ordinance was the foundation of the "Stavnsbaand" (forced tie to homestead). In 1742 this state of bondage was extended to boys in their ninth year, and in 1764 to those in their fourth year; in 1746 an ordinance was issued by which every soldier who had served his time was bound to return to the estate whence he had been recruited, and there receive a farm on forced lease (Fœste). Although this might be supposed to be an advantage, it was entirely the reverse. In consequence of the tyranny of the landed proprietors, many of the peasants or young yeomen emigrated, and it was only by force that they could be made to take land on lease (Fœste). The best proof of the depressed state of the country is found in the fact that the population decreased very considerably in the middle of the eighteenth century.

The system of bondage was thus accomplished, and appeared, if possible, more oppressive than before, for the yeomen could

not forget the liberty they had tasted in the commencement of the century.

But in 1784 the Regent, afterwards Frederick VI., began to take part in the government of the country, and a brighter prospect then arose for the yeomen. The improvement of agriculture, then in a very depressed state, and the emancipation of the yeomen, were the foremost objects of this prince. In 1788 the law respecting the "Stavnsbaand" was repealed, and a commission appointed to regulate the rent and services of the tenants holding hereditary leases, or leases for life; by this act the yeomen were restored to the liberty of which, for centuries, they had been deprived.

The other great drawback to the yeoman's advance and welfare was the manorial labour (Hoverie) to which the proprietors of estates were entitled, the oppressive use of which right had gone hand-in-hand with the "Vornedskab" and "Stavnsbaand." This service appears to have been at first called for in a mild and humane manner, inasmuch as only the yeomen who lived in the neighbourhood of the manor were required to perform it, but in course of time, when the estate was enlarged, it became more arbitrary and ruinous to the interest of the yeoman.

This service was first changed by Frederick VI., as Regent. The royal decrees of 1791, 1795, and 1799, set a limit on this forced labour, and had also for their object the reduction of the number of tenants of compulsory leases. When subsequently a yeoman took land on lease (Fœste) the number of days of labour on the estate, or its equivalent in money, was fixed. Finally, by the law of July 4th, 1850, it was decided that all manorial labour was to cease, and in its place a fixed moderate annual rent to be paid, as soon as one-third of the yeomen bound to perform it, or the proprietor to whom it was due, demanded it; consequently it may now be considered as abolished in the kingdom. In Sleswig and Holstein, where the condition of the yeomen had been even worse, inasmuch as they were serfs, the system was abolished in 1797 and 1804, and, as a result, 20,000 serf-families were liberated; yet in some parts of Holstein and in South Sleswig manorial service can still be called for.

By numerous decrees and laws the Danish government have endeavoured, during the last sixty years, to improve the position of the tenants under compulsory lease (Fœste); the system is still retained, but upon very different and much more favourable conditions, and the expression "compulsory" is scarcely applicable to the system at present, except to distinguish it from that of landlord and tenant as understood in England. Of late years many of these lessees have, by purchase, become the proprietors

of their leaseholds. On all crown-lands such property has been sold to them, and many landed proprietors seem inclined to follow the example. Moreover, an attempt has of late years been made in the Danish Diet to pass a law compelling owners of estates to sell their leasehold tenements to the tenants in possession, at a price to be fixed by a commission appointed for the purpose, less the value of the fine (Indfœstning) paid, in proportion to the unexpired term of the lease. The arguments of the friends of the yeomen lessees are to the effect that the landlords are in reality not the sole proprietors of these leasehold tenements, because by law they are deprived of the power to dispose of them, but that each lessee has, in accordance with certain old, very obscure, and ambiguous legal enactments, a certain claim on them as part proprietors; they further argue that the constitution of 1849 (which enacts that expropriation can take place when the public weal requires it) justifies expropriation in this instance.

The supporters of the landed proprietors insist that public interest (as the framers of the constitution understood it) has nothing to do with the question at issue, and that the paragraph in the constitution cited is only applicable to property situated in localities required for purposes of public convenience; they demand that landlords shall be at liberty to continue the present system, with the option to sell or add such property to their manors when leases expire. In all probability this leasehold system will, in the course of some years, be abolished by voluntary sale to tenants, without recourse to so unjust an act as that which would by law compel landlords to sell their properties: the present proprietors have obtained possession of them by purchase or inheritance, whatever their ancestors may have done, and the holders of the leases in modern days have voluntarily entered into the relations they now complain of. No doubt earlier their condition was wretched, but now their personal and political liberty is as great as that of other classes. To benefit them further, at the expense of the large landed proprietors, appears as undesirable as it would be unjust.

The Rural Population of the Danish Monarchy is divisible into three great classes, viz., the nobility and large landed proprietors, the yeomen who are proprietors or leaseholders, and the labourers.

The Estates of the Nobility of the kingdom, though they form a separate division, do not at present retain any of these especial privileges, which, in earlier time, were very great. They owe their origin to King Christian V., who in 1671 created the

orders of Count and Baron, but these may now be regarded in the same light as other proprietors. Of counties there are 18, of baronies 14, and of other entailed estates 37, in the kingdom; by the constitution of 1849 no property can now be entailed.

In Sleswig, Holstein, and Lauenburg, there are 276 privileged estates, either entailed or not; in either case the privileges belong to the proprietors, whether by entail or purchase; they chiefly consist in freedom from certain taxes, in voting at election of members to the Diet, or of clergymen, judicial officers, &c. In Sleswig some of these privileges have been rescinded of late years.

The second class of properties in Denmark Proper consists of large estates (Herregaarde), which, though not entailed, formerly possessed privileges now abolished; of these there are at present in the kingdom 793.

In the duchies such estates can scarcely be said to exist.

A separate subdivision of these estates is formed by those belonging to different public, charitable, or other institutions. The University of Copenhagen, for instance, possesses land to the extent of 40,500 acres; the college of Sorö 58,750 acres; the provincial municipal corporations in the kingdom 80,625 acres, &c. The total area of such estates in the country may be estimated at 31,500 tons of "Hartkorn" (393,750 acres).

But most of the land in Denmark comes under the head of Yeomen-farms (Bondegaarde), as every property is called having an area of land varying from 1 to 12 tons of "Hartkorn," or 12½ to 150 acres. Of the 377,860 tons of "Hartkorn" in Denmark the said farms comprise 314,843; the larger private estates 35,264; the municipal corporation 6456, and properties of less than 1 ton of "Hartkorn" 21,297. The yeomen-farms in the kingdom number about 70,000, of which about half have from 4 to 8 tons of "Hartkorn."

In Sleswig, Holstein, and Lauenburg, there are about 32,000 similar farms, called Hofs or Boel, besides smaller ones.

There is a great variety in the size or extent of the properties in the different provinces. Thus on the islands, and especially on Sealand, there are comparatively many more large estates than in Jutland, and in the north-east part of Jutland more than in the rest of that province.

The northern part of Sleswig consists principally of yeomen's farms; but the south-east coast of Sleswig and the east coast of Holstein contain the greatest number of large estates which is to be found in the monarchy. Statistical accounts bearing on these duchies are, however, very deficient on the subject of agri-

culture. Far the largest quantity of arable land in Denmark is, as shown, in the hands of the yeoman class, and only about 10 per cent. of the whole belongs to properties having more land than constitutes 12 tons of "Hartkorn." The yeoman-farmer cultivates his own land, and it is quite an exception if he lets part of it. The proprietors of large estates (Herregaarde) frequently farm themselves, with the assistance of a bailiff, who directs the details of the husbandry. The English tenant-system is here exceptional. Of the 1715 properties having above 12 tons of "Hartkorn" of land (including entailed estates), there were in 1850 only 388 thus let. A few years ago this system was more in vogue, and the rent was then frequently so low that the experienced tenant (Forpagter) could make money. But the advance in corn-prices, improvements in cultivation, and the increase in the value of property, caused rents to be raised to an extent disproportioned to the true increase in the land's value; the landed proprietors, unable correctly to estimate the change of times, and observing the prosperity of the old tenants, demanded too high rents, and consequently the able farmer declined to speculate, though persons without means sometimes did so, to the ultimate loss of the owner.

The tenantry-system having decreased, that class which formerly rented land now prefers investing money in its purchase; but as their capital is seldom large, and generally only sufficient to satisfy the vendor, they frequently buy to disadvantage. It is not uncommon that a man with 1000*l.* buys a property worth 5000*l.*, and is obliged to pay from four to six per cent. interest on a large part of the value of the property, which, as a rule, does not pay; whereas if a larger capital were employed the farm might yield a good profit. A sufficient working capital is very uncommon among the agriculturists of this country.

The high prices paid for landed properties at the end of last and the commencement of this century, as a consequence of speculation and high grain-prices, fell to the opposite extreme between 1810 and 1826, partly on account of the deranged state of the finances, and partly on account of wars; so that estates now worth 5000*l.* were then sold for 250*l.* to 350*l.* But, with improved financial administration and the revival of commercial confidence, the prices of landed property rose again until 1857, when the monetary crisis produced an effect which considerably reduced their imaginary value, and doubtless has caused speculators to be more careful than during the period 1856-57, when almost ridiculous prices were paid.

The price of landed property in Denmark may now, on an average, be said to be between 220*l.* to 330*l.* per ton of "Hart-

korn," neighbourhood of towns, quality of land, &c., causing variations. The average annual rent of land may in a like way be stated as between 10*l.* and 11*l.* per ton of "Hartkorn."

THE RELATION BETWEEN MASTER AND SERVANT has materially changed of late years. Earlier most of the labour on large estates was performed by the bondman ("Hoveripligtige"), and only superintendents and herdsmen were living on the property. But when manorial labour ("Hoverie") was abolished the organization of a new system became necessary, the result of which may be thus given:—

On some estates labour is performed by young, mostly unmarried men, who reside on the premises and receive board, lodging, and fixed wages. They are generally engaged for six or twelve months. But as an additional number of workmen is required during summer, especially in harvest time, cottage-labourers, together with their wives and children, are engaged for such periods. Sometimes they are paid day-wages, but more frequently they receive a round sum for the season, whether the harvest is early or late, and the payment is usually made in corn. Other proprietors prefer not having their farm-labourers on the estate, but in cottages in its immediate neighbourhood. The advantage of this system over that where the servant can leave at a few months' notice, seems to be, that a certain number of labourers can be counted upon, who, from long experience, are well acquainted with the agricultural system adopted on the property. As a general rule, they are married, and do not readily quit their cottages, on account of the difficulty of finding others on estates farmed on similar principles. This system also secures, in the wives and children of the cottagers, a sufficient number of cheap female labourers, whereby the cultivation of esculent plants is facilitated.

While these two systems are almost exclusively practised on the larger estates, they are also frequently adopted by the yeomen-farmers.

FARM-WAGES do not vary much in a country like Denmark. The season of the year, the neighbourhood of towns, &c., have, however, a distinct influence on them. In Denmark Proper, before 1846, a male farm-servant received, as a rule, board and lodging and 2*l.* 15*s.* to 3*l.* 15*s.* a year, but since then, on account of the great rise in the price of food, &c., the amount of such wages has been doubled; in some instances even a greater increase has taken place. At present a farm-servant receives about 5*l.* 10*s.* per annum, besides board and lodging: the latter may be calculated at 8*l.* 5*s.*, making a total of 13*l.* 15*s.* A female servant generally receives 3*l.* 7*s.* annually, besides board and lodging.

If the farm-servant lives in a neighbouring cottage, and is paid, as earlier stated, in corn, the expense may be thus given:—

	£.	s.	d.
Rent of cottage with ⅛ acre of garden-land	1	10	0
Pasture and food for 1 cow, 2 sheep, and 1 pig	2	17	4
12,000 pieces of turf	0	15	10
5 barrels of rye, at 13*s.* 6*d.* .. 3 barrels of barley, at 11*s.* 3*d.* .. ½ barrel of buck-wheat, at 9*s.* .. 1½ barrel of malt, at 10*s.*	6	0	10
Cash	2	16	0
	14	0	0

The farm-servants of the yeomen (both male and female) generally receive half their wages in wool, linen, cotton goods, flax, &c., and by this means their masters pay perhaps one-quarter less in wages than larger proprietors. In Holstein wages are a little higher than in the kingdom or in Sleswig. The wages for day-labourers may be estimated at from 10*d.* to 1*s.* 3*d.* for males in the summer, and about 7*d.* in the winter; for females at from 8*d.* to 10*d.* in the summer, and from 5½*d.* to 7*d.* in the winter, but they receive no board or lodging.

The wages of those engaged during harvest only are generally paid in kind, and may be estimated at one quarter of rye, and one quarter of barley for a man, and 5⅓ bushels of rye and 5⅓ bushels of barley for a female, for the season. The Danish farm-labourer is generally well off, and, while he is without family, is able to save part of his wages, as is sufficiently proved by the large sums of money placed in the savings-banks by this class.

Agricultural improvements have of late increased the demand for farm-labour; many Swedes have, therefore, been engaged, especially in Jutland; but, as they are considered inferior workmen, and are frequently persons of indifferent character, the Danish labourer is preferred, and generally receives to the extent of 1*l.* 2*s.* 6*d.* to 1*l.* 13*s.* 9*d.* higher wages annually; the German labourers, who of late have emigrated to this country, are a superior class, and are much employed in the brick-yards and in cutting turf.

The system of living in Fellowship, with equal Division of Land, seems early to have existed here as well as elsewhere, and it was no doubt the proper course for the colonization of the country. Two reasons probably led to its adoption, viz., the protection it afforded against robbers and wild beasts, and the facility provided for the cultivation of land. In Denmark, when a new tract of land was to be cultivated, several persons united for the

purpose. They first took possession of grounds, sufficient land for their immediate wants, and built a village thereon. The land was not at once divided into as many equal parts as there were families, for by such division all parties would not have been fairly treated, but it was in the first instance divided into lots, according to the quality of the soil and the facilities for its cultivation; these were again subdivided into as many allotments as there were families. By this means every yeoman in the village obtained a share of equal size and quality; but the allotments were spread in various directions between those of other owners; and instances are mentioned where one individual has had allotments of land in eighty different places.

This system, well suited to the period, proved the reverse in course of time, inasmuch as no one could undertake improvements in the cultivation of his land without the consent of all his fellow-occupiers, whilst much time and labour was lost in consequence of the distance between the different allotments, and in some cases their distance from the village. This distribution was, however, continued in Denmark until the close of the last century, when, together with the bondage and forced labour, it was abolished. By royal decrees of 1781 and 1792 the redistribution of all lands thus held was ordered to be made in such manner that the land of each individual should, as far as possible, be collected in one place. The next step to be taken was to place the farm-house in the immediate neighbourhood of the land belonging to it; but there are still many yeomen living in villages with their land at a great distance.

The Mode of Agriculture employed under this system varied of course much from that which has since been introduced. Formerly the land was divided into inner and outer fields; the first were used exclusively for the cultivation of corn, while the other was employed as pasture for the cattle. The inner or tilled land surrounding the village was divided into three fields, of which one was sown with spring-seed, generally barley, the second with winter-seed, generally rye, and the third was nearly unemployed, as the miserable grass it produced was scarcely of any use: but during last century the practice of fallowing was introduced.

The increase in the population (amounting in Denmark to 58 per cent. since the commencement of this century), as well as in the value of land, caused this system to be given up. The next step taken was to place part of the outer field under cultivation, which then, year after year, was sown with corn until the soil was exhausted, when it was left for bad pasture, and a further piece in the outer field was cultivated in like manner. By this means the land was so impoverished that want of proper food for cattle, and a consequent reduction in the stock, was the

result. Manure became so scarce that the inner field, which had generally been manured every third year, could then only receive a dressing once in six, or even nine years; so that the land produced year by year less corn, and more weeds.

As soon, however, as living in fellowship was abolished in Denmark, the course of cropping was also changed.

The mode of agriculture next adopted in Denmark Proper was introduced from Holstein, and was called "Kobbelbrüg" (inclosed pasture-land). The climate and the soil of Holstein were peculiarly well adapted for pasture, and the neighbourhood of large towns was advantageous for the sale of dairy-produce, to which great attention was there paid.

As at that period no artificial grasses were known, after the pasture had been broken up by the plough for the production of corn-crops, the fields were left to produce those grasses which, by slow degrees, Nature furnished, and to rest as pasture for many years before they were again capable of producing corn for a succession of crops. This more modern system may be thus described:—A field was divided into twelve inclosures, each of which was in the first year fallowed, then sown with—1, rape; 2, wheat; 3, barley; 4, oats; 5, oats; and then left for six years in grass. Or thus:—1, fallow; 2, wheat; 3, rye; 4, peas; 5, barley; 6, oats; 7, oats; and 5 to 6 years grass, &c. Later, when clover and artificial grass-seeds were introduced, rich pasture was obtained even in the first year, and the rotation of crops was therefore thus modified:—1, fallow; 2, rape; 3, barley; 4, oats; 5, clover; 6, clover; 7, tares and oats mixed; 8, wheat; 9, peas; 10, oats; 11, clover; 12, clover. This rotation, by the frequent use of clover, soon impaired the soil, and consequently has become less general, even in Holstein. Its introduction into the kingdom at the close of last century was due to the necessary abolition of the earlier agricultural system, and to the fact that many natives of Holstein took up their abode in the kingdom on account of land being cheap. At the present moment this rotation may still be found on many estates in Jutland, but modified by local circumstances thus:—7 fields cultivated with 1, fallow; 2, rye; 3, barley; 4, oats; and 3 years clover and grass.

On the Danish islands the rotation of crops is frequently as follows:—1, fallow; 2, wheat; 3, peas; 4, barley; 5, oats; and 3 years clover: or 1, fallow; 2, rye; 3, barley; 4, peas; 5, barley; 6, oats; and 2 years clover. But much depends on the quality of the soil, neighbourhood of towns, facilities for labour, and many other circumstances. In the duchies this is the usual rotation:—1, fallow; 2, rape-seed; 3, wheat or rye; 4, barley; 5, oats; 6, oats and clover; 7, clover for mowing; 8, 9, 10, and 11, grass, and, to a small extent, tares and peas; or this:—1, buck-wheat;

2, rye; 3, rye; 4 to 7, grass; and, in fertile soil, barley and wheat.

The advantage of the English method of avoiding two crops of cereals in succession has of late become clearer to the Danish agriculturist, and in some places it has been adopted. On one estate in Funen, in the neighbourhood of Svendborg, the Scotch mode of husbandry has been introduced; but it is doubted whether the climate and other local circumstances will admit of its more general application. The land must certainly receive higher culture before the English mode of agriculture can become general in this country. This is not said with a view to censure the Danish farming, which must be admitted to be good, all circumstances considered, but it is evident that, where the population on an English square mile is under 100, the cultivation of land cannot be as extensive as in Norfolk, Suffolk, or Lincolnshire, with a population of above 200 to the square mile, or as that of Belgium, with above 340 inhabitants to the square mile. For the same reason the land in Jutland (with a population of 59 to the square mile) is less cultivated than that on the Danish islands, with 150 inhabitants per square mile. With the exception of England, Holland, and Belgium, Denmark is scarcely second in husbandry to any country in Europe.

Agricultural Implements.

The application of steam-power to agriculture is almost unknown here, but the Danish farmer follows, with great interest, the improvements made in farming implements abroad, and, when they are practically useful, all local impediments taken into consideration, adopts them. But he looks with suspicion upon all such improvements as appear complicated. As Denmark is not a manufacturing country, its youth is not educated to look upon machinery with confidence, as in England; nor has it the same chance of obtaining practical knowledge. The Danish farmer has difficulty in properly estimating the value of complicated agricultural machinery, the labourers in using it, and the country mechanics in repairing it. In the latter fact may perhaps be found the great drawback to the use of such machinery, for the only mechanics that can repair it generally live at such distances that, if broken, it could not be made use of again until next season. Less complicated machinery, as the patent chaff-cutter and winnowing-machines, may frequently be met with even on the yeomen-properties. The thrashing-machine, particularly the smaller English one, has of late years been introduced on the larger estates; reaping-machines, which formerly were only mentioned here with a smile, are now being introduced; but local difficulties will, no doubt, limit their

general use. Seed-drills have, on larger farms, replaced the system of sowing by hand, saving of seed and less dependence on weather being the result of their use. Their superiority has now been generally admitted. Of other machines, such as those for cutting roots, for crushing oil-cakes and corn, a few may be found, but they are exceptional, and cannot be said to have any influence on the agriculture of the country.

Ploughs and harrows are generally well constructed, but rollers are very inferior; they are always made of wood, and consequently not heavy enough for their purpose, though, from their peculiar construction, they are too cumbrous for the horses to draw. Of harrows, two kinds are used, both with wooden frames and iron teeth. The one is rectangular, and serves for light work; the other, called the Swedish, is triangular, and is used for deep harrowing. The latter is now considered as indispensable as the plough. Some years ago a very clumsy, heavy, wheel-plough was in common use; it required two men, with four, sometimes six, horses. This is now entirely superseded by the swing-plough (after Scotch or American models) which requires only one man and two horses, and does its work better. Some of these are made entirely of iron, others are of wood and iron; the former form an important branch of the Danish iron manufacture; the latter are made on the farm or by the village blacksmith and wheelwright.

The hand implements have only attracted attention of late years; those now used are generally made after American models.

Treatment of the Soil.—The soil is usually well cultivated. The fallow, first introduced at the end of the last and the beginning of the present century, is now common on all the large farms, and even on those of some yeomen, yet the latter, as a rule, do not appear to understand that the succeeding crops of corn repay the additional labour and the temporary loss consequent upon allowing the soil to rest one year as fallow; they therefore frequently sow a mixture of tares and oats, or some leguminous plant instead, and their land consequently suffers much from weeds, though they freely use the plough and harrow. The land on large estates is invariably better cultivated than that of the yeomen.

The fields are generally ploughed once or twice in autumn and again in spring, after which the Swedish harrow is applied. The Danish farmer, though he carefully cultivates the surface of the land, is unwilling to plough to a greater depth than five or six inches, if as much; on a few of the larger estates the soil is, however, sometimes ploughed deeper.

The scythe is used for harvesting corn, and it is here believed that a labourer can do four times as much work with it as with a

sickle; this saving of labour is of the more importance from the necessity of gathering the ripe corn before the storms, so frequent in this country, destroy it. In Jutland, as soon as the corn is cut, it is tied up in sheaves and placed in heaps, but on the islands it is usually allowed to lie some days before it is sheaved; the first method is, however, rapidly superseding the latter. As earlier stated, the corn is generally placed in barns, and only in very fruitful years is recourse had to stacking. During autumn, but especially in winter, the corn is thrashed; on many of the larger estates this is done by the assistance of machinery, but on the smaller farms the flail is invariably used, and with it a man can generally thrash from 5 bushels to 1 quarter a day; machinery is objected to because the straw is injured by it. Barley is usually thrashed with the flail, or horses are used to tread it out; the hummelling machine is scarcely known here, but of late the thrashing machine has been used for barley. The corn is cleaned by the assistance of either machinery or sieves.

During the last twenty or thirty years much has been done in Denmark in the way of agricultural improvements. The land has been cleared of stones found imbedded in large quantities in the earth, the fields levelled, and deep ditches cut at a distance of from twenty-eight to thirty feet from each other (in lieu of draining),—a system by which, however, more than ten per cent. of land is lost. Three other improvements deserve special notice, viz., the clearing and cultivation of heath and bog land, irrigation of meadows, and drainage.

Clearing of Waste Land.—I have stated earlier that the Danish monarchy has 3256 English square miles of heaths and 1606 square miles of mosses and bog-meadows, of which the greatest area is found in Jutland, namely, 2618 square miles (about 1,675,520 acres) of heaths, or about one-fifth of the area of that province. The cultivation of these heaths and bogs is a question all-important to the government and to private individuals; that of the bog-meadows has generally been undertaken by the latter, whereas the government has paid special attention to that of the heaths. For the purpose of colonizing them, many peasants from Phalzel (the Palatinate) were, at great expense, induced to settle in Jutland in 1759, where they continued for a long period to receive support from the government.

The mode of cultivation varies of course much, but the first step taken is to burn the surface of the turf, as, when this has been done, the soil is easier to work, and the burnt ashes prove valuable as manure. Rye, buck-wheat, or tares and oats mixed, are generally sown first on heaths, or, where the soil is of a better class, oats. The first crop on the reclaimed bog-meadows is generally barley, to render the soil more friable; then rapeseed,

to pay expenses of cultivation; and lastly, oats are sown once, or perhaps several times, before the land is used as pasture.

Large tracts of heaths and bog-meadows still exist, but year by year their area is decreased, and the latter will, no doubt, before long be entirely reclaimed. But the cultivation of the heaths proceeds somewhat more slowly, because the soil is frequently of such bad quality that it is not likely to pay, or only after a long lapse of time.

Some of the heaths have been planted with trees, and to these I shall refer under the head of Woods and Forests.

Irrigation of Meadows.—In Denmark, numerous bays, rivulets, and inlets of the sea, or lagoons, intersect the valleys of the country. The principal of these lagoons—the Liimfjord—formerly had but one outlet, a narrow channel connected with the Cattegat, from which mouth it stretched, in a westerly direction, with long windings, across Jutland, expanding, in various places, into large sheets of water, containing small islands. In 1825, during a violent storm, the isthmus between the North Sea and the Liimfjord was broken down, so that the northern portion of Jutland became insulated; but this new channel is so shallow that it cannot be used for navigation, whilst the opening to the Cattegat has also decreased in depth, so as to be available only for very small vessels. In the valleys thus intersected there is much rich meadow-land, which may perhaps account for the fact that artificial irrigation has only been recently and to a small extent adopted. The artificial water-meadow was first introduced thirty or forty years ago from Hanover. At first natives of that country were chiefly employed to lay out the necessary works, but, as they proceeded on a large scale without considering that the supply of water in Denmark did not equal that of Hanover, their speculations failed, and this failure tended to discourage the introduction of the system. Within the last ten or twenty years, however, irrigation on a smaller scale has been carried on, principally in the western and southern parts of Jutland, and the abundance of hay consequently produced on an indifferent soil has proved of great importance to the large cattle-breeders in that province; it has also been carried out on the east coast of Jutland, but not on the islands, where the fall of water is seldom sufficient for such a purpose.

Within a year or two the irrigation system of the model-farms in England has been practised by a few of the larger landed proprietors in this way:—the manure is dissolved in water, and, by the assistance of pumps, forced through subterranean iron pipes to the different fields, where, by the use of the hose, it is spread over the land. The introduction of this method is too recent to enable an opinion to be formed whether it will prove

remunerative in this country, but farming is scarcely sufficiently advanced to make its general adoption at present very probable.

Drainage was not practised in Denmark until within the last ten or fifteen years, and is as yet only in its infancy; as the usual prejudice against innovations has in this instance been surmounted, the great drought of our late summers and the crisis of 1857 are no doubt the causes why the practice has not been more generally adopted here, for its great advantages are admitted by large as well as small farmers.

There exist no official statements as to the area of land which has been thus improved, but I am informed, upon good authority, that from 12,000 to 15,000 acres of land have been drained, namely, about 5000 on the islands and the remainder in the peninsula.

On the islands of Lolland and Falster, resembling the English fen-counties, drainage is much required, but, the country being flat, it will be attended with considerable expense. On the island of Sealand about two-thirds of the land will require draining, but here the land is more undulating. On the island of Funen the north and north-western districts are flat, and the soil a stiff clay, much requiring drainage. The central part has lighter soil, and will not need it. In the south the land is rich and hilly, and much resembles that of Sealand. On the surrounding small islands draining will scarcely be required.

In the peninsula the soil varies so much that it is difficult to pass any opinion as to the extent of drainage required; it is, however, principally needed on the east coast, whilst on the west it is almost inapplicable, as the land frequently lies so low that it is at times inundated by the sea. The general expense of draining in Denmark may be estimated at 2*l.* 15*s.* to 5*l.* per acre, depending on local circumstances.

As land is seldom let for a longer period than four or eight years, tenants rarely undertake any drainage; in some instances, however, a special contract is made to the effect that the landlord defrays the expense of draining, and the tenant pays from five to seven per cent. on the capital employed. By this arrangement both parties are interested in getting the work well, but also cheaply, executed. Young Danish farmers now frequently travel in England, Belgium, and Germany, to obtain practical knowledge of the different methods of drainage, but the Government has taken no steps to facilitate draining operations.

Manure.—Its inestimable service has so long been generally admitted that it is surprising that in an agricultural country like Denmark, no true interest has been shown, until the last ten or twelve years, in the improvement of this important branch of husbandry. A great deal remains to be done, but yet

the care taken in collecting, preparing, and preserving manure, liquid as well as solid, has very much increased of late on the larger properties. On nearly all those of the yeomen the old indifference on this head remains unchanged, and the manure, with its rich fluids, is wasted to a very great extent; the capital thus annually lost to the husbandman is immense. In those districts where the soil is rich the least care is taken of manure; where it is barren, as in some parts of Jutland, attention has more readily been drawn to its great importance, and, as it is scarce there, it is often mixed with turf and bog-soil.

Marling.—This operation has been used for a long period in some districts of Holstein (the north-east), but it is only within the last thirty or forty years that it has been introduced into the kingdom. The large landed proprietors have adopted the practice, and invariably admit its usefulness, but the yeomen-farmers are still behindhand in its application. On the island of Bornholm marling may almost be said to be unknown; in Jutland it is not very common, principally because the marl has to be brought from great distances.

In the less fertile districts of the country succulent plants, such as buck-wheat, are not uncommonly cultivated for the purpose of being ploughed into the soil, by which means the fertility of the land is much improved; on the coasts sea-weed is much used as manure, but, as a general rule, it is not applied when fresh gathered, which is, no doubt, a mistake. Another kind of manure (that made of fish), elsewhere acknowledged as very powerful, might be employed to a great extent in Denmark, and would no doubt prove most useful; it is, however, almost entirely neglected, though many of the inhabitants of the Danish coasts are occupied in fishing. The heads and entrails of the fish to be dried, and those found dead in the nets, are generally used to feed pigs, or thrown into the sea: a very rich supply of manure is thus neglected. In Norway factories have been established to utilise this raw material, and have proved most beneficial; it appears singular that neither the government nor any private persons in Denmark have paid attention to this subject.

Many of the artificial manures which have been used with so much advantage in England and elsewhere (as gypsum, bones and horns, oil-cakes, &c.) have been tried, but have not found favour in Denmark. A manufactory of patent manure (animalized carbon) has for some years been established near Copenhagen, by an English firm, Messrs. J. Owen and Son. From 1837 to 1846 this manure was much used, especially on the island of Bornholm, but, the results of its adoption not having proved satisfactory, it has since been discontinued and replaced by another artificial manure (superphosphate of lime)

from the same establishment. This is sold at 7*s.* 6*d.* per cwt., and appears to have met with approval. Mr. Owen informs me that he sold 3000 tons (English) in 1857, at 8*l.* per ton. Guano has only of late been tried (it sells at 15*s.* 9*d.* per cwt.), but does not seem to have given satisfaction, probably because the quality imported is inferior and mixed. From the little favour which artificial manures have met with in Denmark, either on account of the average good quality of the soil, or from want of skill in their application, one good has resulted, namely, the greater attention which has been paid to the home supply of manure, and consequently to the fatting of cattle, &c. A large quantity of corn, formerly sold, is now used as food, and thus indirectly transformed into butchers' meat, butter, &c.; if the sale of such corn gave a greater direct return, nevertheless the additional manure on the land, and its consequent increased productiveness, will ultimately prove more advantageous.

The Products of Danish Agriculture.

Horses.—From the earliest times Denmark has been renowned for its excellent horses, and formerly the cavalry of many countries was supplied from hence; even now the export of horses is of great importance to the husbandman, although it has decreased in comparison with earlier times, probably because the breed of horses abroad has improved, and that of Denmark degenerated. The most valuable properties of the horse of this country are beauty, strength, and constitutional hardiness; it is easily fed, but cannot compete with the Arab or the thorough-bred English horse. When horse-racing was introduced into Denmark some twenty years ago, the horse of this country had no chance against those brought from England or Germany. An attempt was made to improve its speed by a cross with English race-horses, but the result was a loss of strength and hardiness. Later the Government, as well as private individuals, have endeavoured to improve the native horse by a cross with the Yorkshire coach-horse, and since 1852 a stud of forty stallions of this race has been kept at Kolding in Jutland. Opinions vary much here as to their influence on the breed of the country, and although they must prove valuable in districts where there is a scarcity of native stallions, yet this will scarcely be the case in the country at large, as their requirements, comparatively speaking, are too great; moreover, the climate does not appear to suit them, and their prime cost is too high.

The qualifications of the Danish horse differ materially in the various provinces, in consequence of the mode of treatment adopted. In Jutland, especially in the northern districts, in the neighbour-

hood of Randers, Viborg, Skive, Thisted, and on the island of Mors, it is well cared for: in these districts breeding is more extensively carried on than elsewhere in the country, and from thence the export of horses takes place, almost exclusively, both to foreign countries and to the different provinces. On the island of Sealand only few horses are bred, and but little care is bestowed upon them. On Bornholm some are reared; they are principally exported to Sweden and Germany, but are not considered very good, and frequently suffer from diseases. In Sleswig and Holstein, principally in the marshes, the horses are of greater size than in the kingdom, but their legs are weak in proportion to the body, and consequently cannot bear very hard work; some of them are handsome, and well adapted for carriage horses.

The number of horses at present in the Danish monarchy cannot be stated correctly, as the latest statistical reports on the subject bear the date of 1838 for the kingdom, and 1845 for the duchies. Such statistics are, however, promised this year (1860). At the periods referred to there were in the kingdom 254,449 horses in the rural districts, 12,373 in the towns, and 58,198 colts and foals, making a total of 325,019. Sleswig had 55,000 and Holstein 70,000 horses of different ages. No returns exist as to Lauenburg. The annual increase by breeding is estimated at 24,000.

The export of horses depends much upon political events, or rather upon the demand for horses abroad for cavalry purposes. The largest export is to Prussia, Mecklenburg, Hanover, Hamburg, Lübeck, and sometimes to France. During the last five years the export has been as follows:—

1854	13,020 horses,	whereof to	England 142
1855	12,286	,,	,, 14
1856	8,727	,,	,, 40
1857	9,768	,,	,, 20
1858	9,032	,,	,, 6
1859	17,374	,,	,, 21

On an average the price of horses exported varies from 16*l.* to 30*l.*, though some few are of much higher value.

Horned Cattle.—It is generally considered that the breeding of cattle ought to form one of the most important sources of revenue to the Danish farmer; yet, for want of sufficient care, it does not, comparatively speaking, now hold as important a position as earlier. Until within a few years the breed of cattle here was deteriorating from want of proper attention to the quality and pairing of the breeding stock, inefficiency in practical knowledge in its selection, foolish economy in rearing the young cattle, and, finally, bad keeping and tending; but of late years

very great improvements have taken place in all these respects, and at present good, if not superior, cattle may be found on the larger estates all over the country.

Of the different breeds I will specially mention that of Jutland; it is of moderate size, well formed, and hardy; the cows give a great deal of milk; if well fed, this race fattens rapidly, and the quality of the meat is good. It appears well adapted for Jutland, because it thrives on good as well as on indifferent soils. The Angeln race (in Sleswig) is a variety from that of Jutland; in this district special attention is paid to the production of milk, and the Angeln cow is scarcely inferior in this respect to any, if well fed; but if not, it scarcely gives as much milk as the Jutland cow. The largest horned cattle in the Danish monarchy are to be found in the marshes of Sleswig; the cows there are well known for the quantity of milk they give, which is, however, not as good as that of the Angeln race, but they do not thrive except on this rich pasture-land. Various attempts have been made to improve the different breeds, but without great success. In 1804 the Government imported horned cattle from Switzerland and the Tyrol, but they did not thrive, and have disappeared. English and Scotch bulls have of late years been imported; among others the Ayrshire race, but although the cross has at times appeared advantageous, yet the general opinion is not in favour of it. On the west coast of Jutland, and in the marshes of the duchies, successful experiments have been made in crossing with the English "short-horn" race, but the general objection to this practice is, that the Danish cattle thereby lose their qualities of frugality and hardiness, and become less suited to the climate and other local circumstances.

What I have stated on the subject of statistical returns with respect to horses is applicable to horned cattle and other animals.

The number of horned cattle in the Danish monarchy was:—

In the Kingdom of Denmark in 1838	850,000 heads.
In the Duchy of Sleswig in 1845	280,000 „
In the Duchy of Holstein in 1845	250,000 „

The total number would now doubtless not fall short of two millions.

The quantity of milk obtained from the several races of cows, in different districts of the monarchy, varies, as before stated, from 8 and 10 to 20 and 30 quarts per day; those on the heaths of Jutland and Sleswig give the least, those in the marshes the most.

The most extensive dairies are to be found on the large estates on the east coast of Sleswig and Holstein, and the next on those

in the Danish islands, and in a few districts of the east coast of Jutland. On an average it is calculated that on the larger properties on the islands and in Jutland, each cow gives annually from 75 to 90 pounds of butter; but in the duchies, more especially in Holstein, cows are known to give as much as 154 pounds: whereas the yeoman farmer seldom obtains more than 60 pounds. It is usually calculated that the profit on a cow varies from 2*l.* 15*s.* to 3*l.* 7*s.* 6*d.* a-year, but, by good feeding, it may be brought to 4*l.* 10*s.* Formerly the cattle were ill-fed during winter, and, when turned out on pasture-land, they were excessively meagre, but of late years a favourable change has taken place in this respect; now cattle are fed during winter on corn, esculent plants, oil-cakes, &c., and when turned out into the fields they are strong and healthy, and consequently give better returns. But there is still great room for improvement in the mode of feeding, inasmuch as sufficient attention is not paid to the digestive properties of the food given to cattle, and it is sometimes supplied too often, viz., seven or eight times a day; again, too sudden changes are made from one kind of food to another, whereby temporary illness is frequently caused.

With respect to the buildings and utensils of the dairies, I may observe that the first are very indifferent; as a general rule, cold in winter, warm in summer, damp, badly ventilated, &c. Latterly attention has been drawn to these defects, especially in Holstein, where a profitable dairy-system has existed for centuries past, and consequently early reforms may be looked for. Wooden pans have hitherto been almost exclusively used to keep the milk in; now and then earthen vessels were met with; within the last few years, however, iron pans have been introduced; they are large, roomy, and, comparatively speaking, do not require much space; they are easily kept clean, and in the course of time they will doubtless prove cheaper than those of wood, but their principal advantage is, that in warm weather the milk is quickly cooled and the formation of cream thereby facilitated.

The dairy management of yeomen farmers is, as earlier stated, very bad, but on the larger estates all over the country it is otherwise. Butter from the latter has of late fetched high prices in the London market, but I am informed it has principally been sold under the name of "Kiel" butter on account of the discredit earlier attached to that produced in the kingdom.

Though the consumption of butter is greater in Denmark than in any other country (in Denmark 20 to 30 pounds, in England 6 to 8 pounds, in Prussia 2 pounds per head annually), yet it forms, next to grain, the most important article of export. During the last twenty or thirty years the shipment of butter has greatly increased, and from Holstein it has nearly doubled. In the com-

mencement of this century the export from the Danish monarchy varied from 57,488 cwt. to 86,232 cwt.; from 1830-34, it averaged 116,336 cwt. annually until 1856, when it reached 180,886 cwt. In 1857, 1858, and 1859, it fell considerably in consequence of want of grass from continued drought. During the last six years it has been:—

	Barrels of 246 lbs.		Barrels.
1854	81,406,	whereof direct to England	4,574
1855	78,645	" "	4,261
1856	82,355	" "	5,560
1857	58,800	" "	1,376
1858	55,289	" "	1,406
1859	56,412	" "	1,133

Of these quantities from two-fifths to three-fifths came from Holstein, and, comparatively speaking, more from Sleswig than from the kingdom. In the beginning of this century about 1000 barrels were annually imported into the kingdom from the Duchies of Holstein and Sleswig, but this is changed, and many thousand barrels are now annually sent from the kingdom to the duchies for the purpose of being there resold for exportation. Formerly large shipments of this article took place from Kiel direct to England; now that route is no longer used, and consequently the export to England appears, by the above table, very small, whereas the fact is, that large quantities are annually sent there indirectly, by way of Altona and Hamburg, to which places more than half of the butter exported now goes; Norway takes from 13,000 to 19,000 cwt., and Lübeck from 2600 to 3500 cwt.

The sum which the sale of butter annually brings into the country varies from 550,000*l*. to 800,000*l*., or about one-third of that produced by the export of grain. The price of this article has very much increased within six or eight years: while from 1840 to 1852 it varied from 2*l*. 5*s*. 6*d*. to 2*l*. 14*s*. 6*d*. per cwt., in 1853 and 1854 it began to rise, until, in 1856-1857, it reached 4*l*. 15*s*. to 5*l*. 6*s*. sterling per cwt., which prices, with slight variations, have since continued.

Cheese.—Until some few years back the production of cheese was of little importance in the kingdom of Denmark, where only common cheeses were made; it was otherwise in Sleswig and Holstein, whence from two to three million pounds were annually sent to the kingdom, and one million pounds abroad, but these cheeses were of inferior quality (cost price 2½*d*. to 3*d*. per pound). During the last ten or twenty years the proprietors of some of the larger estates have paid special attention to the manufacture of this article, and considerable quantities are now produced, which fetch from 5*d*. to 7*d*. per pound. However, the importation from abroad has not decreased.

The import and export of cheese to and from the Danish monarchy during the following years may be thus given:—

Imported.

Year.	lbs.		lbs.
1854	417,833,	whereof from England	7,087
1855	374,032	" "	10,674
1856	447,374	" "	8,708
1857	477,014	" "	7,218
1858	430,279	" "	6,033
1859	463,288	" "	7,042

Exported.

Year.	lbs.		lbs.
1854	821,194,	whereof to England	21
1855	966,205	" "	838
1856	910,789	" "	..
1857	1,008,891	" "	267
1858	722,582	" "	2,373
1859	635,939	" "	2,864

Though the quantity exported is nearly double that imported, nevertheless the value of the latter is greater on account of its superior quality. More than half of the cheese imported comes from Holland, the remainder from Hamburg, Lübeck, Norway, and England; half of that exported goes to Sweden and Norway, the remainder to Mecklenburg, Lübeck, Hamburg, and England. The annual consumption of cheese in the rural districts is about 30 pounds, in the towns it averages 16 pounds per head.

Fatting of Oxen.—Up to the commencement of the last century fatting and exporting cattle were among the principal sources of income to Denmark. At that time stall-feeding was the special privilege of the great landed proprietors, and, in consequence, there were then more than 350 estates in Jutland alone where oxen were stall-fed. This privilege was rescinded in 1788; this fact, together with the increased profits derived from the dairy by the emigrants from Holstein, the imposition of an export duty, change in the state of trade, and, finally, cattle disease (which, in the year 1745, reduced the number by 285,160 head), induced many landed proprietors to exchange their oxen for cows; the fatting of oxen has since then constantly decreased, but now there seems a chance of a favourable change: it is at present carried on principally in the northern and western districts of Jutland, and in the marshes of the Duchies of Sleswig and Holstein.

The cattle exported from Jutland are of two kinds, either such (aged from five to eight years) as are sent direct to a market at Copenhagen or Hamburg, or those (aged from three to five years) which are sold to be fatted on the rich pasture of the marshes, and thence sent to England or Hamburg. In central Jutland and in the north and west parts of that province the

latter plan is principally adopted, and from thence between 25,000 and 30,000 horned cattle are annually sent to the marshes. The former plan is followed in the east and north-east districts of Jutland. A greater desire has been evinced of late years to fatten cattle in Jutland, in consequence of the facilities afforded by direct trade with England, and there can be no doubt but that increased steam-communication and greater commercial intercourse with Great Britain will assist in removing the Danish farmer's fear and prejudice against starting his cattle for a distant market, and at the same time relieve him from the loss sustained by sending them thither indirectly.

Besides the large number of live cattle, a considerable quantity of salted and smoked meat is exported. This trade has increased very largely within the last thirty years. In 1831 the export of smoked and salted meat was only 706,000 pounds, while, ten years later, in 1841, it was 3,256,382 pounds; a decrease took place for a short time, but the export was again increased, though the consumption in the country is considerable. Thus it is calculated that in the towns 90 to 100 pounds of fresh meat and 45 to 50 pounds of pork, and in the rural districts 22 pounds of meat and from 45 to 50 pounds of pork, are annually consumed by each individual; while in Prussia the consumption is calculated at only 35 to 45 pounds per head.

The export of horned cattle, calves, smoked and salted meat from the Danish monarchy during the last six years may be thus stated:—

Year.	Horned Cattle.	Calves.	To England.		Smoked and Salted Meat.	To England.
			Oxen.	Calves.	Pounds.	Pounds.
1854	54,408	11,936	21,312	3	2,976,745	206,000
1855	50,678	13,974	19,392	..	2,027,361	357,031
1856	44,902	14,886	18,354	..	2,181,270	425,635
1857	51,247	13,770	19,980	4	2,881,949	324,298
1858	39,403	12,466	15,183	2	2,455,885	398,832
1859	50,170	10,083	22,196	..	2,704,759	173,905

England receives the largest part of the oxen exported, next come Hamburg (from which place a large number is doubtless again sent to England) and Lübeck. The calves exported are principally sent to these latter towns. The largest quantity of meat is sent to Norway, next come Hamburg, England, Danish West Indies, Sweden, and Greenland. The reduction in the export of 1858 arose from the drought of the previous summer. That the export direct to England has greatly increased within the last fifteen years will become evident when a comparison is

made between the above table and the one to follow. I must, however, observe that the export of meat to England has at times been greater than in 1845; whereas very few head of cattle were sent there previous to that year.

In 1845 were exported to England 57 heads of oxen, and 44,694 pounds of meat; in 1847, 3020 heads of oxen, and 100,590 pounds of meat. In the year 1853 the largest export of oxen to England took place, viz., 23,878 heads.

Oxen are rarely used for draught purposes except in the peninsula.

Sheep.—By the latest published statistical tables it appears that there were in Denmark Proper in 1838 1,700,000 sheep; in Sleswig, in 1845, 180,000, and in Holstein in the same year 140,000. In these duchies large flocks of sheep are only met with on the foreland outside the dykes of the marshes. With respect to the kingdom, the number of sheep in Jutland is threefold that on the islands, because they can thrive on the almost barren and hilly land of that province, where cattle cannot. On the heaths of central and west Jutland the sheep proves the most important, and frequently the only domestic animal. By its frugality and hardy nature it enables the yeoman farmer of these barren districts to obtain a subsistence.

The native Danish sheep is between 2 to 2½ feet in height, and about 3 feet long. When in good condition it weighs on an average 50 to 55 pounds. It is hardy, and easily fed, has very little wool on the body, short wool on the legs and tail, generally of a rough, coarse texture. It is shorn twice a year (spring and autumn), and gives on an average 2½ to 3 pounds of wool. It is found on the heaths of Jutland, where a better race cannot exist, because it has to live in the open air during a great part of the winter. In other parts of Denmark the sheep are of a mixed breed.

Of foreign breeds may be found the Merino sheep. In 1797, 300 of these were imported from Spain for one of the royal sheep-folds, which, in 1824, counted 1600 of this race. It soon spread over the country on account of the finer wool, which fetched double the price of other kinds: but as this sheep requires a care and attention which the smaller farmer cannot bestow, it is only to be met with on the larger estates, where German shepherds are then generally employed. The interest taken in the Merino sheep has, however, of late much decreased, partly because the race, by cross-breeding, has deteriorated both with respect to quality and quantity of wool, and partly because from the increase in the consumption of mutton the farmer finds more profit in selecting sheep for their flesh than for their wool. The "Dishley" and "Southdown" races have therefore been

introduced with a view of breeding sheep in which both meat and wool of superior quality may be combined.

On the island of Bornholm the sheep are very inferior: of late an attempt has been made to improve the breed by the introduction of English rams.

The yeoman farmer employs nearly all the wool of his sheep in home manufacture; the large sheep proprietors sell theirs to the weavers, of whom there are forty-two in Denmark, or to the cloth manufacturers, of whom there are twenty-six; but the cloth produced is generally coarse; the finer sorts used in the country are imported principally from England, Germany, and Belgium.

Of the wool annually produced in Denmark the largest quantity is used in the country. Of manufactured woollen goods the export is but small: in 1859, for instance, only to the value of 18,000*l.*, while during the same year 670,779*l.* worth of such goods was imported, showing how little the country is able to supply its own requirements in this article.

The export of sheep and wool, and the import of wool, may be thus stated:—

Year.	Export of Sheep.	Whereof to England.	Export of Wool.	Whereof to England.	Import of Wool.
	Number.	Number.	Pounds.	Pounds.	Pounds.
1854	32,305	12,887	3,675,266	1,026,512	1,691,302
1855	25,768	9,798	3,362,165	1,015,669	1,689,224
1856	28,962	10,175	3,420,823	1,286,858	1,481,827
1857	35,675	17,756	3,155,549	1,258,070	1,385,424
1858	28,714	10,033	3;901,415	2,147,506	1,128,989
1859	40,445	18,371	3,621,387	2,114,461	1,045,624

England imports the largest number of sheep; next come Hamburg and Lübeck.

Nearly all the wool imported comes from Iceland: of late years the importation has, however, fallen off, in consequence of disease among the sheep there. The wool sent to England is mostly of the coarser kind; the rest goes to Sweden, Hamburg, Lübeck, Norway, and Holland.

Swine.—But little attention is paid here to the rearing of swine, at least on the smaller farms. Of late years more pains have been bestowed on the building of sties, as well as the improvement of the race, by a cross with hogs imported from England, or the better class reared in the country. The English swine are highly esteemed here, on account of their prolific nature, their great weight in flesh, and because they thrive on little food, and supply pork of fine flavour. It is chiefly on the Danish islands that the Yorkshire race has had a considerable influence on the breed. The Jutland pig is larger, but not as

easily fed as the smaller one of the islands; it has not been much crossed by foreign breeds, and in some parts of this province, for instance, the south-west, the aboriginal race is still to be found.

Danish history states that one hundred and fifty years ago wild boars were so plentiful that Christian V. in 1692, in one boar-hunt on the island of Sealand, killed thirty-three of them, and in Jutland their final extermination took place within the memory of man; they are still to be met with in the forests of Lauenburg.

According to the statistical reports, there were in Denmark Proper in 1838, 320,000 pigs, in Sleswig, in 1845, 44,000, and in Holstein 68,000; but since then the number must have greatly increased. As the fatting of swine is most profitable where there are dairies, it is natural that the duchies should, comparatively speaking, have the largest number of them, and, for a similar reason, they are more numerous on the islands than in Jutland. The export of swine from the Danish monarchy has considerably increased during the last fifteen years, and may be said, on an average, to be four times as great as during the years 1836-1846. The export of pork has also increased, but not in the same proportion.

The swine are principally exported from Holstein, and almost exclusively to Hamburg and Lübeck; about 1000 are annually sent to Norway.

The pork (whereof eight-ninths is salted and one-ninth smoked) was formerly sent chiefly to Hamburg, but now England and Norway share in the exports, in almost equal proportion with that city, so that these three places receive from three-fifths to four-fifths of the entire quantity exported; of the remainder Sweden, the West and East Indies, and Greenland, receive a considerable share.

Export of Swine and Pork.

Year.	Swine.		Pork.	
	In Number.	Whereof to England.	Pounds.	Whereof to England.
1854	43,957	78	4,051,276	657,571
1855	43,418	48	4,889,079	1,540,499
1856	50,180	3	3,926,407	1,076,328
1857	43,706	7	4,040,631	760,566
1858	40,802	21	3,340,071	827,083
1859	55,769	186	5,784,845	1,787,973

Cultivation and Product of different Crops.

Corn is the chief article of export from Denmark; it is consequently the produce on which the interest of the agriculturist is

mainly concentrated. Rising civilization, increased value of land, and, above all, the demand from consumers abroad, especially in England, for corn of the finer sort, now oblige farmers to bestow great attention and care on the quality of their grain. Earlier this was not the case, and at the close of the eighteenth century the Danish corn stood lowest on the list in English grain-markets. This bad corn, nevertheless, found a profitable market in Norway, when Christian VI. in 1735 had forbidden the import of foreign corn into Denmark, and forced Norway to take its corn from thence. Writers on agriculture show that at that period corn was sold consisting of 32 per cent. rye, 38 per cent. weeds, 17½ per cent. chaff, dirt, &c., 4 per cent. corn-cockle, 2½ per cent. peas, 2 per cent. oats, 2 per cent. wheat, 1 per cent. barley, and 1 per cent. tares.

After the repeal of the law referred to in 1788, and more especially after the separation of Norway from Denmark in 1814, merchants were compelled, in their own interest, to take the quality of the grain more into consideration, and at present it is the exception when even the yeomen farmers deliver "dirty corn;" and evidence is everywhere found of a strong desire to supply this article in superior quality; and consequently great attention is paid to the selection of seed-corn and the preparation of grain for sale. Good seed is obtained by the use of larger and better winnowing-machines, by frequent purchase of clean and heavy seed from abroad, or from the better districts of this country (for instance, from the north-east part of Holstein), by the introduction of different kinds of wheat from England and Scotland, and by interchange of seed among the farmers of the country, especially of those kinds which most readily degenerate, &c. Improvements in these respects have, as is usually the case, been commenced by proprietors of large estates, and in the districts where these are numerous, the soil rich, and shipping ports are at hand, the benefit has been most marked. And this example has been followed by the yeoman farmer. Where the advantages have not been so apparent, reforms have been made more slowly. Progress in this respect is most noticeable on the islands, and in the fertile districts of the peninsula.

A strong motive for additional care and attention arises from the fact that it is becoming more and more the usage with the dealer to buy his corn by weight and measure. Formerly all grain was bought by measure alone, and the merchant, for fear of offending the vendors, did not dare to pay different prices, though the qualities varied considerably. The old practice is doubtless still common in many parts of the country, but where the larger estates are situated, grain is sold according to weight and measure, and it is believed that this practice will soon become

general; before such time it cannot be expected that the yeomen farmers will pay sufficient attention to the delivery of good, weighty, and clean corn.

But the improvement in quality of the grain is also, in a great measure, due to the Danish corn-merchant, who of late years has paid great attention to its treatment after delivery to him. Many of the dealers have imported and use grain-drying apparatus to prevent mildew, and bestow great care on the sorting, winnowing, and casting of corn. This is the more necessary from the fact that in purchasing from the yeomen in small parcels, often of different quality, they are only able to obtain a merchantable article by great care in the sorting, &c., before shipment.

Wheat.—The sort most cultivated in this country is the hardy red wheat, not much subject to blight; until within the last twenty or thirty years this was the only kind grown, and its indifferent quality was the reason assigned for wheat not being more generally sown; foreign varieties were then introduced; for instance, Wheathington wheat* from England, which, however, did not prove sufficiently hardy for the climate, and, again, from Poland; but this did not succeed either, because it suffered too much from blight. About fifteen years ago another kind of English wheat (here called Manchester wheat) was introduced, which proved suitable, and is now largely cultivated all over the country.

As land has been improved by cutting ditches, by artificial drainage, and by a better supply of manure, the cultivation of wheat has become more general, so much so that before long it will probably replace rye on the more fertile soil, although on the more sterile land of Jutland rye will continue to be the staple grain for food. In Holstein and in the marshes of Sleswig the cultivation of wheat has long exceeded that of rye. Twenty years ago four-fifths of the wheat exported from the Danish monarchy came from these duchies, while at present they do not supply half of the total export. The production of wheat in the whole monarchy is now calculated at nearly a million of quarters, and of this quantity the duchies supply about 450,000 quarters.

The wheat from Denmark Proper is seldom as weighty as that from Holstein or the Baltic provinces, but it is not far inferior in quality. As an average weight of the wheat produced in the kingdom, 128 to 131 pounds Dutch per barrel (equal to 61½ to 63 pounds English per bushel) may be given. The Holstein wheat is generally a couple of pounds heavier.

The export of wheat during the last twenty or thirty years has increased largely; from 1830 to 1839 the annual export did not

* A white wheat, probably named after the importer.

exceed 95,000 quarters, while from 1854 to 1859 it averaged about 390,000 quarters.

Rye.—This species of grain may truly be called the bread-corn of Denmark. In Jutland, more especially on the heaths and on the west coast, scarcely any other is known. On the Danish islands there is not half as much rye produced, comparatively speaking, as in Jutland, whilst in the duchies its cultivation is only general on the heaths: it is never sown on the marshes, and consequently the kingdom supplies the duchies with a considerable quantity of this grain. Formerly the old Danish dark-brown rye predominated all over the country, but early in this century a different species was introduced from that part of Holstein called the "Provsti" (north-east district); it is lighter in colour, heavier, thin-husked, and more productive; wherever the soil is good it has superseded the old Danish rye, which is now, on account of its hardiness, chiefly cultivated in the less fertile districts of Jutland. A third kind of rye imported from Belgium (campine-rye) seems likely to supplant that last named; it is not as light in colour or as weighty, but it gives a much larger crop, and is for that reason much esteemed. Good Danish rye is in weight equal, and sometimes superior to that from the Baltic provinces: on an average the best will weigh from 120 to 122 pounds Dutch per barrel (or $57\frac{1}{2}$ to $58\frac{1}{2}$ pounds English per bushel); in Jutland it generally weighs less, in Holstein more. Above 2,400,000 quarters are annually produced in the Danish monarchy, but, as it forms the chief bread-corn of the country, the export is but small. During the years 1854 to 1859 it averaged only about 240,000 quarters; at an earlier date, however, no rye was exported, but imports of that grain took place.

Barley may be mentioned as the most important article of export from Denmark, and, next to oats, the largest grain crop of the country. On the Danish islands more barley is cultivated, comparatively speaking, than in Jutland; in the duchies it is raised to any extent only in the marshes. Of the 2,400,000 quarters of barley, the annual average produce of the monarchy, not one quarter comes from the duchies of Sleswig and Holstein, which formerly, in less fruitful years, were even supplied from the kingdom.

In all the fertile districts of the country the two-rowed barley (*Hordeum distichon*), which has a fuller kernel, has, to a great extent, supplanted the six-rowed barley (*Hordeum hexastichon*). On the west coast of Jutland, however, the six-rowed barley is most common, because it is the hardiest, requires less rich soil, and is better adapted for an inclement and stormy climate, as it ripens earlier and is not so easily destroyed by wind. The

Chevalier barley was much in vogue, ten or twenty years ago, in some of the provinces of Denmark, but has never become general on account of the length of time it requires to ripen.

The Danish barley is of superior quality, and usually surpasses that of the Baltic provinces in weight; it is therefore much esteemed in foreign markets. As a general rule, it has a weight of 110 to 114 lbs. Dutch per barrel (or 53 to 54 lbs. English per bushel), but sometimes exceeds it. In the north-west part of Sealand, in the neighbourhood of Callunborg, the finest barley of the country is to be found, and here it sometimes weighs from 118 to 120 lbs. or even 122 lbs. Dutch per barrel (56½, 57½, to 58½ lbs. English per bushel). I am, however, informed that complaints have of late been made, especially in England, against the Danish barley, on the ground that the beard is broken off too close, for the sake of gaining weight and compactness in the sample, by which operation the kernel loses its germinating power, whereby its value, as malting barley, is diminished; this, together with the heavy malt-tax in England, is the reason why Danish barley of late years has, comparatively speaking, been quoted at a higher price in Hamburg than in London. Since thrashing machines have become more general in Denmark, the farmers often use them for their barley, by which great labour is saved; but no doubt the barley suffers more by such operation than when thrashed with the flail or trodden out by horses. Corn-dealers complain that, since the thrashing machine has been used for such purpose, the kernels are often cut in two, and the principal brewers of this country object to purchase barley thus thrashed.

The export of barley from Denmark is now, and always has been, larger than that of any other kind of grain. During the last twenty years it has considerably increased, though not in the same proportion as other grain.

From 1830 to 1840 the annual export of barley was about 380,950 quarters; from 1855 to 1859 it, however, averaged 660,000 quarters.

Oats.—This is the largest crop grown in the Danish monarchy. In Jutland it is especially cultivated, and forms about forty-two per cent. of the entire harvest of that province; it is also largely raised on the Danish islands, but not to the same extent as in Jutland or the duchies, where, especially in the marshes, it grows most luxuriantly. The yeomen farmers prefer a narrow-kernelled and pointed species of oats, called the old Danish, but on the larger properties the common white variety, introduced from England and Mecklenburg, is chiefly cultivated. The average weight of the Danish oats is 78 to 82 lbs. Dutch per barrel (or 37½ to 39½ lbs. English per bushel).

The Danish monarchy produces annually, on an average, 3,571,000 quarters of oats, of which half in Jutland. Though the production is larger than that of any other kind of grain, yet the export is but third in order, the home consumption being very large. The annual export does not now exceed 370,000 quarters, but twenty years ago it was only about 140,000 quarters.

Buck-Wheat is principally cultivated where the soil is least fertile. In Jutland, especially on the west coast, it constitutes one-tenth of the entire grain harvest. In the duchies it is also grown, particularly in the more sandy soil of their central districts. Its cultivation is not generally profitable, because of the great uncertainty of the yield, which varies from two to sixteen fold. The export of buck-wheat is very variable. In 1854, 66,736 quarters were exported; in 1857, only 12,540; in 1858 and 1859 the export averaged 25,437 quarters, of which Holland and Belgium receive the largest quantities. The average weight of the buck-wheat is about 110 to 114 lbs. Dutch per barrel (or 53 to 54 lbs. English per bushel).

Peas.—The culture of this plant is confined to some particular districts. On the islands of Moen and Falster they constitute about twenty per cent. of the harvest, but they are also cultivated on the islands of Bornholm and Laaland and in the southern parts of Sealand. In the duchies they are met with only in the marshes, the north-east districts of Holstein, and on the island of Femern. Different varieties are grown, among which may be mentioned the green and the grey vegetable peas, and the small green and grey, used as fodder for cattle.

The export of peas is trifling, though it has increased within twenty years from about 24,000 to 42,000 quarters.

Beans are cultivated only in the most fertile districts of the duchies, principally in the marshes, where they grow luxuriantly. Since 1845 the export has more than doubled, and now averages 25,000 quarters.

Potatoes.—About twenty or twenty-five years ago the cultivation of this root increased to a great extent in Denmark, till it became the principal food of the yeoman and the peasant, but the disease which attacked it in so many countries in 1845 also affected it here, and since then its production has materially decreased; thus, previous to 1845, about 1,140,000 bushels were annually exported, while, since that time, the export has scarcely reached half that quantity; they are principally sent to Hamburg and Norway. From the potato a spirit is distilled, of which a considerable quantity is used in the country and some exported to Sweden. But, while the potato has of late received less attention, other plants have received more; for instance, beet-root, cabbages, and turnips; and it is evident that in a few years they

will form an important branch of the agriculture of the country. On most of the larger properties one or more acres is assigned for their exclusive growth. The general drawback to more extensive crops on such estates is the want of a sufficient supply of labour; this objection, however, is not so applicable to the more numerous farms of the yeomen, on which, no doubt, these plants will soon enter more extensively into the rotation.

Though many varieties of garden cabbages are raised, they cannot be considered as forming an object to agriculturists.

Rape.—This plant was early and extensively grown in Holstein for the seed, and during the first thirty years of the present century it took an important position in the agriculture of that duchy; from thence it was introduced into other parts of the monarchy, and, in consequence of the high price it fetched, and its great productiveness, was highly approved of; but during the last twenty years it has been much less cultivated, not only on account of the decrease in the yield (caused by injuries received from insects and worms in the flowering season), but also because it was often entirely destroyed by the frost in winter, so that the land had to be reploughed in spring; and again because it proved exhausting to the soil, and, finally, because grain-prices have increased so much that the balance of profit is now in their favour. The general opinion is that, as the system of converting agricultural produce into meat and butter, by feeding cattle with cereals, &c., advances, so the cultivation of rape will diminish.

The only districts in the monarchy where it is yet met with to any extent are those of the north-east of Holstein and the marshes, especially the latter.

Among the different species of rape cultivated may be mentioned winter rape (*Brassica Napus oleifera*), which, in favourable years, gives better returns than the "Rübsen" (*Brassica Rapa oleifera*), which, on the other hand, is less infested with insects. The first-named is grown in the kingdom, the last in the duchies.

Between 1830 and 1839 the export of rape averaged 96,143 quarters annually, in 1840 it rose to 133,297 quarters, but in 1855 it did not reach 37,000 quarters, while in 1859, 105,663 quarters were exported; of these quantities two-thirds were the produce of the duchies and one-third of the kingdom. Holland receives about half, and England, Belgium, and Hamburg the remainder. The export of rape-cakes averaged, between 1830 and 1840, 11,000,000 of English pounds annually; since 1844 it has increased, and reached about 22,000,000 lbs.; the largest quantity is shipped to England.

Flax.—The cultivation of this plant is generally decreasing in Denmark; it is to be met with in most districts, but on so limited a scale that it seldom more than suffices to supply the

personal requirements of the producer, and is far from sufficient for those of the whole country. The superior and cheaper yarn brought from England and Germany, together with the increased demand for finer linens, cause the farmers to hesitate before they grow a plant which is even more exhausting to the soil than rape, and demands an expensive and laborious treatment. Another reason why less attention is paid to the production of flax may be found in the fact that, with one exception (at Frederiksborg), no flax-spinnery of any importance exists in the country. In the north of Funen, where the Government established one in 1793, the largest crop of flax was then raised, but since this spinnery has been discontinued it has decreased also there.

Between 1,000,000 and 2,000,000 lbs. of flax are annually imported, principally from Russia, independent of from 2½ to 3½ million lbs. of linen and yarn, obtained from England, Belgium, and Prussia. Of flax-seed, the import exceeds the export by 11,000 to 14,000 quarters annually.

Hemp.—The same may be said of this plant as of flax; its cultivation decreases annually, and it is only raised on a limited scale in particular districts; for instance, on the island of Samso and in the neighbourhood of Rendsburg. The import of hemp therefore averages from 3½ to 5½ million pounds annually, and takes place principally from Russia.

Hops.—This plant is principally cultivated in gardens, and only to a small extent. Angeln, in Sleswig, and the north-west of Funen make exceptions in this respect, but the hops raised in Funen are not considered good, and are chiefly sold to the yeomen farmers for domestic use. Close upon 1,000,000 lbs. of hops are annually imported into Denmark, principally from Germany.

The cultivation of other plants, such as tobacco, carraway, mustard, &c., is so extremely small in Denmark as scarcely to deserve attention.

The influence of the British corn-law of 1845 on the grain-trade and husbandry in general of a country like Denmark must of course have been most favourable. Formerly, the corn of Denmark was largely exported to Norway, but the trade created by this law was soon turned to some, though not the best, account, because the grain of the country was then not sufficiently good to suit the English market, and consequently, while the exports in the early years after 1845 increased largely, they decreased for a time afterwards. But, by improved agriculture, better corn has been raised, more attention has been paid to winnowing and sorting it, &c., and the result has been a considerable increase of trade with Great Britain. The accompanying table (marked E) first shows the general export of the

agricultural products of the Danish monarchy for the six years 1854-1859, then the separate export to Great Britain and Ireland before and after 1845, and finally, that for the six years 1854-1859.

Garden Culture.—Except on the larger properties little attention is paid to gardening. In the northern and western districts of Jutland even fruit-trees are rarely met with. In a few places the yeomen farmers seem to feel an interest in gardening, particularly in the south of Funen and on the island of Taasing, where, attached to each yeoman-farm, is found an enclosed piece of land planted with fruit-trees, hops, and ornamental flowers. In the south of the island of Sealand, and on Moen, the yeomen farmers cultivate a good many fruits, especially cherries and plums. In Sleswig, by Sundeved, and on the island of Als, great attention is paid to fruit-trees; and here may be found a most excellent apple, called "Graasteen," introduced from Holland or Italy by the Duke of Augustenburg, and called after his estate, where it was first planted.

The attention of the Danish government was long ago directed to this subject. Christian II. was the first who invited certain Dutch families to settle in the country, for instance on the island of Amager (near Copenhagen); the cultivation of vegetables forms their principal occupation; a taste for gardening is also visible on the island of Nordstrand (on the west coast of Sleswig), where these settlers have, by great labour, reared many fruit-trees, though the inhabitants of the marshes in Sleswig have in vain tried to do so.

Woods and Forests.—Though Denmark has less woodland now than a century ago, yet the islands and the east coast of the peninsula are well supplied. At the close of the last and the commencement of the present century, the woods and forests suffered much by a general and ill-planned system of felling trees. Between 1764 and 1774, a great deal of crown-land, with the woods appertaining to it, was sold to private persons, who, to obtain large returns for their money, felled and sold the trees; this lasted until 1805, when a law was published for the kingdom, compelling those who thus cut down trees to plant others in their place: by this law the country is secured against the destruction of its woods, which not only benefit it by the firewood and timber they supply, but also by the protection they afford, in an agricultural point of view, against storm and weather. No law of the kind applies to the duchies of Sleswig, Holstein, and Lauenburg, and the fate of the woods there is doubtful.

According to statistical returns the woods and forests of the Danish monarchy cover about 880 English square miles, or 4 per cent. of the total area of the country; they may be thus

subdivided:—Those on the islands and in Jutland cover about 345,000, those in Holstein 62,500, those in Sleswig 50,000, and those in Lauenburg 42,500 acres of land. The largest in Denmark is the "Grib-forest," on Sealand, which covers an area of 22 English square miles.

Of all the trees grown in the country, the most important is the "beech," which can scarcely be surpassed in any part of the world. It is the national tree of Denmark, and constitutes five-sixths of the woods. The oak comes next, of which two kinds are found; the summer oak (*Quercus pedunculata*), and the winter oak (*Quercus sessiliflora*). The former is the most common, the latter being now only found in a particular district in Jutland and on Bornholm. This tree is usually only found in small groups in the beech-woods, yet in some places, as on Laaland and in Holstein, considerable oak-forests are to be met with. The fir, which was formerly the principal tree of Denmark, appears to have been so totally exterminated in the beginning of this century, that nearly all the specimens now found have been planted since that time; but as they grow quickly even in indifferent soil, and consequently give good returns, great attention is paid to their culture, and they will perhaps at some future day again take the lead in the forests of Denmark.

Besides the above, the elder, birch, aspen, elm, maple, lime, and other trees, are met with. Of these, the elm and the birch have earlier been of great importance in this country, but they are not so now.

A favourable change has of late taken place in the general management of the woods and forests, particularly the large forests and those under the superintendence of government or of keepers specially educated for the purpose, and required to pass examinations previous to their appointment. But the smaller woods, belonging to the yeomen farmers, are often badly managed, and afford indifferent returns. Those on the island of Bornholm, with the exception of the royal woods, are ill cared for.

Several thousand acres of land, unsuited for agriculture, are annually planted with trees, almost exclusively firs; this is more particularly the case with a great part of the barren land in Jutland, and is done partly on private account and partly on that of government. The firs thus planted, though they do not grow very rapidly in this sterile soil, exposed as they are to the stormy weather, are yet likely to give a better return than that at present derived from the heaths, as miserable pasture for sheep. On one estate in Jutland, "Frijsenborg," the property of Count Frijs, 448,691 fir-trees were planted lately in one year.

The use made of the timber is two-fold: for building purposes and for firewood. Formerly, when there was plenty of

oak in the country, the timber in most houses was of that material, but it is now found cheaper to import fir and pine timber from abroad, the firs of this country being too young for such a purpose. The oak of the country is exclusively used for ship-building, and is not sufficient to supply what is required for that purpose.

The import of timber is therefore considerable : thus, about 400,000 to 500,000 cubic feet of oak, 5,000,000 to 6,000,000 cubic feet and about 80,000 commercial lasts of fir are annually imported. The oak comes principally from Pomerania, the fir chiefly from Norway and Sweden, but also from Prussia, &c. The forests of beech are most valuable in supplying fuel ; in woody districts it is exclusively used ; where there is less woodland, peat replaces it. The import and export of wood for fuel are about equal ; for, while Hamburg and other places are annually supplied with about 20,000 fathoms of beechwood, a similar quantity of fir for fuel is imported from Prussia.

PEAT is, as already stated, the chief fuel in the districts destitute of wood, and, fortunately for Denmark, there are many turf-bogs in the country ; they cover an area of 1650 English square miles, or about 8 per cent. of the monarchy ; they are spread nearly all over the country, with the exception of the marshes in the duchies, where, from the absence of wood as well as of peat, fuel is obtained with difficulty ; as a substitute, a kind of turf, which is dug at low-water from the bottom of the sea, on the coast, and the straw of wheat and stems of rape are frequently used for baking purposes.

The supply of peat varies much in quality. That found in Jutland, spread to no great depth over a large surface, is very loose and light, seldom weighing more than 16 to 26 pounds per cubic foot ; it burns easily, but does not give great heat. The bogs or pits in Sealand, though less extensive, are deep, and give a more compact turf, which affords greater heat ; one cubic foot of this turf generally weighs 35 pounds. The people are not economical in working the peat-bogs, partly from their great extent and partly for want of draining, which prevents digging to a greater depth than 5 or 6 feet ; this is particularly the case in Jutland. On Sealand some Hanoverian turf-cutters have of late been introduced, who, by greater skill, are able to dig deeper, so as to effect a great saving ; they adopt the Westphalian method of kneading the turf in wooden boxes, thereby producing a superior peat.

On the island of Bornholm, which is destitute both of wood and turf, coal is found about 16 to 20 feet below the surface, in layers extending to a depth not yet ascertained. These seams are of various thickness—from a couple of inches to a couple of

feet. The coal is found principally on the west coast of the island, by Rönne and Hasle. Formerly each yeoman dug for coal on his fields as he pleased; lately, however, a company has been formed for the purpose, but it does not appear to have shown great energy, for the greatest depth reached in the pits is 80 feet. The mines have consequently not given the returns which they probably might give under better management, but they prove of great service in supplying the island.

The total annual production is from 6000 to 7000 English tons of inferior quality, very sulphurous and ashy, giving but little heat, and incapable of being burnt to coke. With respect to heat, 9½ cwt. of Bornholm coal is equal to 6 cwt. English coal. The very small general importance of this supply will be evident when I mention that, in 1859, 413,116 tons of coal were imported into the monarchy exclusively from Great Britain.

FIELD SPORTS have ceased to be an occupation for profit, as was once the case, when the forests were more extensive, and the game and wild beasts more plentiful. As late as 1772 wolves were found in Denmark, and, until the commencement of this century, wild boars; the latter are even now to be met with in a royal forest in Lauenburg. Deer, once so plentiful, are now found only in the royal and private parks. One royal park (Jœgersborg), a few miles from Copenhagen, contains about 200 stags and 800 does; the number of hares and foxes has of late materially decreased, and continues to do so. On the west coast of the peninsula a few wild rabbits may be met with.

The swan, the wild goose and wild duck, partridges, snipes, fieldfares, and, on the heaths in Jutland, the heath-birds, are the most common birds in Denmark. The west coast of the peninsula is often frequented by a large number of sea-birds during a brief period of the season, in particular by a species of wild goose. On the island of Ertholm, in the Great Belt, and on the islands on the west coast of Sleswig, a number of eider-ducks are found.

Of old the right of killing game was restricted either to the proprietors of the large estates or to the king; the latter generally transferring his right to the "Amtmœnd" (county sheriffs), who obtained a considerable revenue by leasing out their privilege.

After the constitution of 1848 was granted, such an exclusive privilege was, in the opinion of the country, contrary to the idea of liberty and equality, independent of the damage suffered by the unprivileged. In consequence the game-law of 1851 was issued, by which the yeomen and all others are allowed to kill game on their own land; but it appears doubtful whether this general right has not proved injurious, for the game, useful as

food, was soon reduced in number, as well as the birds or animals that destroy insects, vermin, &c.

There are many intelligent farmers who, without wishing to see the present game-law repealed, desire to have some clause added by which protection should be afforded to such birds and animals as seem by nature destined for the destruction of vermin, &c., which of late years have increased enormously, causing greater damage to the farmer than any he suffered from the depredations of wild birds and beasts.

FISHERIES.—In olden times the number of fish in the Danish waters was very large. Saxo Gramaticus (the chronicler of the twelfth century) says of the Oresund, "that it was so full of fish that ships could scarcely get through, and that fishing-apparatus was not required, as the fish could be caught by hand." This statement is of course exaggerated; yet it indicates that there must have been great abundance of fish, which is further attested by the existence in earlier times of many fishing villages on the borders of the Sound, which disappeared as the number of fish decreased. The same historian says of the Liimfjord, "that fishing appeared to afford as much revenue to the inhabitants as agriculture."

It is not easy to ascertain the cause of the great decrease which has taken place in the supply of fish on the Danish coast, except in the Liimfjord, where it is supposed to be due to the irruption of the North Sea, whereby the water became salter and the current stronger. The last time that the fisheries in the Liimfjord gave large profits was in 1828: so many herrings were then caught that 100,000 barrels were exported; since then the returns have been very small.

Though the supply of fish has decreased, there can be no doubt that fishing might be made remunerative, but this does not at present appear to be the case, as only about 2½ per cent. of the population are occupied in that way, while agriculture, as earlier stated, gives employment to more than 60 per cent. of it. The only reason that can be assigned for this is, that the inhabitants find employment in the fields as profitable, more easy, and less hazardous than the life of fishermen; but it might be otherwise if these were supplied with better tackle, and taught the best and most economical way of curing and salting fish. They are so ill provided at present that frequently, when a large and unexpected number of fish is caught, they are obliged to throw many into the sea again, or use them as food for pigs, &c.

On the fertile coasts of Sleswig and Holstein scarcely any natives are employed in fishing, but small smacks come from Blankenese (in the Elbe), and take all they catch to Hamburg. On the west coast of Jutland, from the barren nature of the

land, nearly the entire population is engaged in fishing, and principally lives upon fresh or cured fish; near the Scaw the inhabitants chiefly maintain themselves by catching flounders. Further south, on the east coast, where the soil is more fertile, few persons are thus occupied, and these only when fish are abundant. This may be said of part of the bay of Randers, where a great many salmon are sometimes met with. In like manner herrings are found plentifully in the firth of the "Slie," in Sleswig, and sprats in the bay of Kiel. It is surprising that the several wide bays and inlets in Denmark are seldom visited by herrings, while the "Slie," with a narrow passage, is rich in this fish. The right of fishing in the "Slie" belongs in part to the inhabitants of "Cappel" and in part to the proprietors of entailed estates along the said firth or bay. The herrings caught here are smoked in Cappel, and thence sent to different parts of the country. The sprats caught in the bay of Kiel are also smoked, and exported in considerable quantities.

On the Danish islands the principal fisheries are on the borders of the Great and Little Belts, where many eels and herrings are caught, and on the east coast of Sealand, from Copenhagen to the north of the island. On this latter coast several villages are situated, where the population maintain themselves entirely by fishing, and principally supply Copenhagen, Elsinore, and other places with fish, such as cod, mackerel, sprats, soles, &c. On the island of Bornholm considerable salmon and herring fisheries exist.

Oysters and dolphins are found in certain districts. The dolphin, which, in the spring, enters the Kattegat and Baltic from the North Sea, is caught only in two places in any number, viz., near Middelfart, on the island of Funen, and "Jœgersprüs," on Sealand; in the latter place there is a special guild, established in 1693, and called the "Dolphin-hunters' Guild," which consists of thirty members; at this place about 1000 dolphins are annually caught. The oyster-banks are not of great importance; the principal ones are those near Frederikshavn, and on the west coast of Sleswig, from Fano to Pelworn; the oysters from the latter banks are exported *viâ* Flensburg to St. Petersburg, Copenhagen, or Germany, under the name of Flensburg oysters. About 200,000 are annually taken by Frederikshavn, and more than 3,000,000 on the west coast of Sleswig; these banks are government property, and are leased to private individuals for about 2500*l.* annually. Of late years oyster-banks have been discovered in the "Liimfjord," in Jutland, and it cannot be doubted but that others must exist in Denmark.

A few seals are shot near the Danish coasts.

From the mismanagement of the fisheries, there is little or no

export of fish, whereas from 10,000,000 to 11,000,000 pounds of salted, smoked, or dried fish, are annually imported, principally from the Faro islands and from Iceland. A considerable quantity of fish is annually sent from hence to Prussia, not of native produce, but principally in transit from Norway, &c.

Bees.—In 1838 there existed in Denmark Proper 85,000 bee-hives, and about the same number in the duchies, where more care was bestowed on them than in the kingdom. Most attention was formerly paid to the bees on the east coast and on the heaths of the peninsula, where the wild flowers and the buck-wheat afforded them a suitable nourishment. Each yeoman has generally a couple of ill-made hives, which he manages badly, in the old-fashioned way. But the great interest of late created in Germany by the treatment of bees by Mr. Dzierzons (a clergyman in Silesia) has fortunately awakened a similar feeling in this country; in the keeping of bees great improvement may therefore be looked for by the introduction of Mr. Dzierzons' system.

The annual export from the Danish monarchy averages 45,000 to 50,000 English pounds of honey (whereof 16,000 to 18,000 pounds to England), about 110,000 pounds of wax (of which only 400 or 500 pounds to England), and 10,200 gallons of mead, of which nearly all goes to Norway.

Iron.—Denmark has no mines, but near the bogs, especially in Jutland, a ferruginous ore is to be met with at a depth of one to two feet; it is said to contain from 30 to 50 per cent. of iron, and is called "Mose-ahl" (bog-metal). Earlier, when communication with foreign countries was attended with difficulty, this ore was used by the yeomen for smelting purposes, but never in larger manufactories. From old deeds of conveyance and other documents it is seen that taxes were frequently paid with this ore. About twenty years ago an attempt was made to use it on a larger scale, and it was found to yield 26 per cent. of iron, easily smelted, suitable for cast, but not for wrought iron. The experiment failed, and since then no notice has been taken of the ore.

Amber is washed up on the Danish coasts, but, in most places, in very small pieces and quantities, and of late not so frequently as earlier. On the west coast of Jutland, however, it is gathered in stormy weather in such quantities that its collection proves remunerative; the annual value of the produce may be stated at about 800*l.*

Of other mineral produce met with in the Danish monarchy may be named gypsum, from Segeberg in Holstein, where 6000 to 7000 barrels are annually obtained. Cement-stone is found on Bornholm as well as lime-stone; the latter, when polished, resembles black marble

Salt is extracted from sea-water on the Jutland coast. Near Oldesloe in Holstein exists a brine-spring, which annually furnishes from 700 to 800 English tons of salt.

The domestic Industry of the Rural Population of Denmark is not only of importance in its pecuniary results, but from its influence on the moral and social condition of the people. The women in the agricultural districts commonly manufacture all articles of woollen and linen clothing used by the yeomen and peasants. The number of domestic weaveries in Denmark Proper was some years ago about 17,000: they are found more particularly in the poorer and less fertile districts, especially on the island of Bornholm. The product of these weaveries is readily disposed of to domestic servants and the working classes, who look more to strength than appearance. During late years the number of these weaveries has somewhat diminished, probably in consequence of the improved condition of the yeomen, who are now frequently clad in better kinds of cloth.

Wool-knitting is a national employment. In the heath-districts of Jutland, where it is most practised, children from four to five years old are taught, and consequently obtain great expertness in the art. Not more than from 1*s.* 6*d.* to 2*s.* 6*d.* a week can, as a general rule, be earned by knitting; but then this frequently does not interfere with other occupation. Thus while the shepherd watches his flocks, or when the labourer is going to the fields, he knits stockings, mittens, &c., without interruption: if the female servant is cooking, or sent to the fields to milk the cows, she knits all the time. Something like 30,000 to 35,000 English pounds of wool are thus annually turned into something useful, principally under-waistcoats, drawers, stockings, socks, and mittens. The quality of the under-waistcoats and drawers is so good that they are sought not alone in the country, but also abroad; but the foreign demand has resulted in less attention being paid to the quality than the quantity produced.

The making of Pillow-Lace was introduced into the Danish monarchy from Westphalia in 1646, and was chiefly adopted as a trade in "Tonder" and its neighbourhood (in Sleswig). More than 1500 females are constantly engaged in this way, and about 10,000 others seek an occasional occupation by such employment. This lace is strong and beautiful; it is generally made to order, and for account of some trader who supplies the thread and patterns. The bargains made are so close that these industrious people gain but a miserable pittance, seldom exceeding 2½*d.* to 5*d.* a day.

Making Wooden Shoes is principally the occupation of the peasants in the woody districts of Jutland: 600,000 pair are thus annually produced for sale, independent of those made by the

farm-servants for themselves. They are in general use, not only among the rural population, but also among the labouring classes in the towns. None are exported.

Potteries.—The yellow Bornholm stone-ware and porcelain are of superior quality, and many graceful water-vases, figures, &c., are manufactured from them. But the only product of domestic industry in this branch is the black clay-pots, commonly used for boiling purposes all over the country. They are manufactured by females, principally in the south-west districts of Jutland, and are not only used in the country, but exported to some little extent.

Brick-Works.—The use of bricks in modern farm-buildings has been already referred to. It has lately been forbidden by law to use timber as the framework of houses in towns, and the manufacture of bricks has very considerably increased in consequence. Nearly all over the country brick-clay is to be met with, and in some places, of a superior quality. In the duchies 400 brick-works exist, furnishing annually 100,000,000 of bricks, besides 5,000,000 to 6,000,000 of tiles, and about 1,000,000 of pantiles. In Denmark Proper there are 800 brick-works, but they are on a smaller scale than in the duchies, and only supply 100,000,000 of bricks, besides a considerable number of draining-pipes. The fuel principally used is peat, but, when the works are situated near the coast, a considerable quantity of coal is used. Though the number of bricks produced in the Danish monarchy is considerable, it does not suffice for the consumption of the country, and consequently importation takes place.

Public and Private Institutions and Societies for the Advancement of Agriculture.

I have frequently had occasion to allude to the general prosperity of the agriculture of Denmark, but, however considerable this may already be, its future development must materially depend upon the theoretical and practical information and knowledge gathered, and the intelligence with which they are spread. It must be admitted that the Danish agriculturist is not remarkable on account of his power of invention, his quickness at devising expedients, his shrewdness or ingenuity; yet the diffusion of general knowledge among this class is considerable, and its steady advancement is provided for by the establishment of schools, and the education of intelligent teachers. Denmark may be proud of the progress made in this respect within the last twenty years. During this period fourteen public schools, for young men above the age of eighteen, have been established in different parts of the country, having as their special object to give the pupils a thorough agricultural education. Such a system cannot fail to prove beneficial to the future farmers of the country.

These schools are almost exclusively established through the liberality and public spirit of private individuals, who have been supported in their honourable undertaking by the Government, by public institutions, and agricultural societies. These schools have generally from 300 to 400 pupils, principally of the yeomen-families, and the favourable result of such institutions is already visible on the farms of this important class.

The government founded in 1856-1858 a school on a large scale for the education of all persons directly or indirectly connected with agriculture, gardening, or the veterinary science, which bears the name of the "Royal Veterinary and Agricultural School," and is situated in the neighbourhood of Copenhagen. Young men here obtain an excellent and very cheap education, which, no doubt, will prove most useful, whether their future calling be that of a cultivator of land or a public functionary, indirectly connected with the veterinary science, agriculture, or gardening. Though the formation of this school is but of recent date, yet it has already done some good service, and the government has been fortunate in the selection of managers and teachers.

Of equal importance is the "Royal Society of Rural Economy" of Copenhagen, founded in 1769, which ever since has had a most important influence on the husbandry of the country. It has promoted, and, in some instances, offered prizes for treatises and books on this science; it has given pecuniary assistance to men who wished to travel for the purpose of gathering practical knowledge; it has caused lectures to be given on agriculture; it has furnished different schools and parishes with books, newly-invented implements, &c. Its capital is above 16,000*l.*, independent of considerable annual subscriptions.

Public agricultural meetings are frequently held in different districts. On these occasions the exhibition of animals, agricultural implements, and produce takes place, discussions are held, and prizes distributed. With a similar object a general meeting of agriculturists, from all parts of the country, is held every other year, in some locality previously agreed upon.

The number of original writers on agriculture has considerably decreased during the last ten or fifteen years, and this branch of literature is at present too much confined to translations from German or French works, neither suited to the circumstances of this country nor appreciated or understood by the general farmer of Denmark: I am, however, informed that one of the able directors of the "Royal Veterinary and Agricultural School of Copenhagen" is preparing an original work on the subject, and have no doubt that it will prove a most valuable acquisition to the agricultural literature of the country.

Table E.—AGRICULTURAL PRODUCTS OF THE DANISH MONARCHY.

Compiled by Harry Rainals, British Vice-Consul, Copenhagen.

General Export for the Six Years from 1854 to 1859 inclusive.

Year.	Buck-wheat.	Barley.	Peas.	Oats.	Wheat.	Rye.	Tares.	Rapeseed.	Beans.	Malt.	Grits.	Flour.
	Quarters.	Quarters.	Quarters.	Quarters.	Quarters.	Quarters.	Quarters.	Quarters.	Quarters.	Bushels.	Pounds.	Pounds.
1854	66,736	653,349	110,467	133,210	402,284	226,437	10,338	125,460	35,190	59,154	6,606,906	4,139,665
1855	50,201	757,339	63,746	424,055	370,510	462,425	9,327	36,974	25,912	75,101	7,364,836	8,463,931
1856	24,455	595,395	55,189	282,055	280,430	240,725	8,715	70,251	24,503	59,970	5,456,103	12,441,704
1857	12,540	612,016	16,248	338,446	394,975	157,440	4,004	119,929	24,438	86,499	10,530,954	11,551,270
1858	25,895	590,986	43,793	325,848	422,333	200,654	1,042	83,934	28,347	43,371	5,575,231	9,807,738
1859	24,978	727,806	43,288	379,606	487,486	626,827	4,719	105,663	20,243	48,221	7,583,699	13,075,576

Year.	Horses.	Horned Cattle.	Sheep.	Swine.	Meat.	Pork.	Butter.	Cheese.	Skins and Hides.	Animal Horns and Bones.	Wool.	Oil-cakes.
	Number.	Number.	Number.	Number.	Pounds.	Pounds.	Pounds.	Pounds.	Pounds.	Pounds.	Pounds.	Pounds.
1854	13,020	54,408	32,305	43,957	2,976,745	4,051,276	20,058,438	821,194	4,520,124	9,465,427	3,675,266	27,005,761
1855	12,286	50,678	25,768	43,418	2,027,361	4,889,079	19,376,918	966,205	3,439,487	6,466,879	3,362,165	30,388,692
1856	8,727	44,902	28,962	50,180	2,181,270	3,926,407	20,292,272	910,789	4,348,582	6,186,047	3,420,823	23,632,405
1857	9,768	51,247	35,675	43,706	2,881,949	4,040,631	14,488,320	1,008,390	5,569,584	7,978,176	3,155,549	22,245,130
1858	9,032	39,403	28,714	40,802	2,455,885	3,340,071	13,623,209	722,582	6,204,969	8,998,023	3,901,415	16,476,142
1859	17,632	50,170	40,445	55,767	2,704,759	5,784,845	15,272,576	635,939	6,569,741	7,194,732	4,010,714	24,523,778

SEPARATE EXPORT to GREAT BRITAIN and IRELAND, before and after 1845.

Year.	Buck-Wheat.	Barley.	Peas.	Oats.	Wheat.	Rye.	Tares.	Rapeseed.	Beans.	Malt.	Grits.	Flour.
	Quarters.	Quarters.	Quarters.	Quarters.	Quarters.	Quarters.	Quarters.	Quarters.	Quarters.	Bushels.	Pounds.	Pounds.
1842	..	12,660	4,688	38,754	34,257	..	241	31,207	1035	..	11,000	33,000
1845	464	14,481	26,085	95,052	61,923	538	10,954	5,307	9096	..	12,451	171,229
1847	15,168	261,952	49,724	225,263	68,028	2994	10,074	20,035	6711	..	469,995	1,784,630

Year.	Horses.	Horned Cattle.	Sheep.	Swine.	Meat.	Pork.	Butter.	Cheese.	Skins and Hides.	Animal Horns and Bones.	Wool.	Oil-cakes.
	Number.	Number.	Number.	Number.	Pounds.	Pounds.	Pounds.	Pounds.	Pounds.	Pounds.	Pounds.	Pounds.
1842	..	217	..	81	256,675	257,591	722,682	352	368,015	7,480,000	467	15,400,000
1845	..	57	..	2	47,450	22,089	79,094	113	228,339	7,411,637	1,047,406	19,786,950
1847	26	3020	2836	152	110,649	360,758	399,907	25,292	58,825	6,017,597	597,762	20,175,631

SEPARATE EXPORT to GREAT BRITAIN and IRELAND, from 1854 to 1859 inclusive.

Year.	Buck-wheat.	Barley.	Peas.	Oats.	Wheat.	Rye.	Tares.	Rapeseed.	Beans.	Malt.	Grits.	Flour.
	Quarters.	Quarters.	Quarters.	Quarters.	Quarters.	Quarters.	Quarters.	Quarters.	Quarters.	Bushels.	Pounds.	Pounds.
1854	44	342,079	60,034	245,069	282,231	1,051	6726	36,999	17,055	..	29,320	997,285
1855	620	299,049	40,937	351,264	241,181	4,505	5954	4,849	11,133	..	13,473	1,315,007
1856	..	268,866	23,860	161,561	163,964	257	6063	5,184	5,447	..	2,228	457,778
1857	286	356,704	4,677	231,016	272,126	12,666	2487	21,911	7,672	305	817	323,128
1858	51	360,959	25,071	198,228	274,156	12,905	199	4,420	3,469	57	160,725	4,319,122
1859	..	464,832	25,675	189,473	301,083	10,313	2490	3,502	3,318	..	332,726	5,326,264

Year.	Horses.	Horned Cattle.	Sheep.	Swine.	Meat.	Pork.	Butter.	Cheese.	Skins and Hides.	Animal Horns and Bones.	Wool.	Oil-cakes.
	Number.	Number.	Number.	Number.	Pounds.	Pounds.	Pounds.	Pounds.	Pounds.	Pounds.	Pounds.	Pounds.
1854	142	21,312	12,787	78	206,000	657,571	1,127,033	209	925,408	7,670,523	1,026,512	25,170,347
1855	14	19,392	9,798	48	357,031	1,540,499	1,049,910	827	219,836	4,524,717	1,015,669	27,765,999
1856	40	18,354	10,175	7	425,635	1,076,328	1,369,984	..	869,004	4,202,011	1,286,858	21,690,759
1857	20	19,980	17,756	3	324,298	760,566	341,246	267	1,307,662	5,786,912	1,258,070	21,053,283
1858	6	15,183	10,033	21	398,832	827,083	346,438	2372	1,671,495	7,423,214	2,147,506	13,434,038
1859	21	22,196	18,371	186	158,095	1,787,973	279,171	2864	1,963,534	6,228,210	2,114,461	20,015,658

XVII.—*The Application of the Manure of the Farm.* By Professor Tanner.

Prize Essay.

The judicious employment of the manure of the farm can scarcely be looked upon as of less importance than its economical production; and when we consider the influence that this fertilizer has upon the produce, and consequently upon the profits, of the farm, we have a strong inducement to give the matter our careful attention. For this purpose it will be advisable to treat the subject under two distinct heads, according as the animal excreta may or may not be intermixed with straw.

Class I.—Animal Manures, intermixed with Straw.

This includes the most expensive manures which are produced upon our farms. We have in that heterogeneous mass so familiarly known as farmyard-manure the great representative of this class. The evidence of practice is agreed respecting its great value, and the improvements which have been introduced into agricultural practice have a powerful and direct tendency to increase the quantity and improve the quality of this product of the farm. Our attention has now to be directed to a subsequent stage—its application to the land.

If we appeal to practice alone for an answer to the question before us, viz., What is the best period of the rotation and the best time of the year for applying the manure of the farm? it will at first sight appear almost impossible to elicit such a reply as will enable us to establish any definite rules, in consequence of the widely-varying customs of different districts. But this want of agreement need not cause us much surprise; for it is clear that as the conditions of soil and climate vary they must be met by corresponding modification in our practice. I do not know any branch of farm management in which the truth of this principle is more evident than in the use of dung. There is scarcely any crop for which farmyard-manure has not been used with advantage; and throughout every month of the year we have instances of its successful application. In explaining and justifying this diversity of usage, we must take the result of successful practice as our primary guide; for science can rarely do more than explain the causes of a success already achieved, and cannot be recognised as an independent authority. Acting upon this principle, we will first notice—

The Practice of Applying Dung to our Heavy Soils, such as Clays and Clay-Loams.

Fallows.—On clay soils the manure is commonly applied to the fallows, and my own experience leads me to consider this to be a judicious practice. If, in some cases, lime is used as a substitute for dung, this will arise rather from the difficulties of providing an adequate supply of the latter than from choice. The combined, or rather consecutive, use of the two substances will generally be found highly beneficial. The time for applying the dung will depend upon the condition of the land, as well as upon the other and more urgent demands both on the supply of manure and the horse-power of the farm. After the cultivation of the wheat and bean crop has been attended to, the fallow-land and that under preparation for roots will demand attention; so that however desirable the autumn application of manure to the summer fallows may be in an abstract point of view, practically these fields will rarely be clean enough to warrant this proceeding, even if manure can be spared for the purpose. It is clearly impolitic to lay on dung in the autumn or early winter, unless we have been able to conquer the weeds, which, if undisturbed, would gain strength and ascendancy from this supply of nutriment. Moreover, except in those few instances in which stall-feeding during the summer is carried out, the autumn stock of manure will be the product of the previous spring, and consequently become thoroughly rotten, and for this reason be less valuable for the fallow ground than for a crop. The condition of the dung has an intimate connection with its application, and the question may fairly be asked, Whether the condition must not regulate the time of its application? To which we, however, reply that this condition is under our control, and may be made to accommodate itself to the general economy of the farm.

Throughout the management of a fallow two objects have to be kept in view:—1st, The improvement of the texture of the soil, so as to fit it for the growth and extension of the roots of the crop; and 2ndly, The liberation and development of fertilizing matter for the nourishment of the plant. The strong soils upon which alone fallows have been found desirable are so close and retentive in their character that there is some difficulty in preserving a free passage for roots. This important mechanical condition of the soil is attained by various tillage operations, which we denominate fallowing, as well as by the use of manure. It will be evident, upon a moment's consideration, that the less decayed the dung may be the greater will be its firmness and

rigidity, and consequently the mechanical influence which it is capable of exerting upon the soil will be in the same proportion. Thus, when fresh dung is ploughed into a strong clay soil, it offers a certain amount of resistance to its particles again returning to their former close and adhesive condition; whereas, if thoroughly rotten manure were used, it could offer no resistance, but the entire mass would again become compact. In the latter case, the soil is enriched, but no additional facility is given to the roots to obtain the supplies which are added for promoting the growth of the next crop; in the former instance the fresh manure adds food for the crop and offers facilities for its use.

We have other reasons which favour the application of dung to the fallows whilst the fermentation is in its earliest stage. In the fermentation of dung, we have important chemical changes taking place amongst the elements which enter into its composition. The great object in fermenting manure is to bring waste matter from the animal body and certain products of vegetable life into such a condition that they can again be useful for the support of vegetation. This fermentation of the dung may be carried out in two ways: the one will materially diminish its fertilising powers; but by the other plan the change may be controlled so that the manurial properties may, in a great measure be preserved, although some slight loss is inevitable. I have estimated, from the analyses given by Dr. Voelcker* as the results of an examination of farmyard-manure in its fresh and also in a well-rotted condition, that the ingredients in very superior manure, calculated at their market-value, are worth 1*s.* per ton more when the dung is in a fresh condition than when it has become thoroughly decayed. This loss is experienced when the manure has been carefully fermented for experimental purposes; but when the decomposition takes place under careless management—when, for instance, the drainage from the manure is not carefully preserved—the waste is far greater, so as materially to affect the finances of the farm. In the application of dung in the early stage of the fermentation, we have this change taking place in the soil under circumstances which ensure us against loss; for we know enough of the power of these retentive soils to be assured that what is entrusted to their custody will be safely retained for promoting vegetable growth.

The best evidence as to the store of fertilizing matter obtainable from the soil by tillage is the fact that some are disposed to rely exclusively on this supply for their successive crops.

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* Royal Agricultural Society's Journal, vol. xvii.

Without entering into the merits of this mode of culture, or attempting to define either the limits of fertility thus obtainable or the economical advantages or disadvantages attendant on such a system, we at once recognize the great value of this supply and the importance of employing all ordinary means for its development. In the use of farmyard-dung we may materially assist this decomposition of the soil : for, when the manure is added in a fresh and unfermented state, whilst its decay is taking place in the land it promotes the decomposition of the materials in the soil, and thus renders them available for vegetable growth. In this manner we not only add a certain quantity of manure to the land, but, by applying it so that its decay shall take place in the soil, we gain from the inert and inactive portion of the soil a further contribution of fertilizing matter. This influence would be considerably reduced—I might almost say lost—if the same manure were employed in a well-rotted condition, because it will have passed through its fermentation, in which stage it exerts this influence. This is, therefore, an additional reason for checking the decomposition of the manure until it has been applied to the fallow-land. If there is a sufficient supply of dung free for the fallow and the land is tolerably clean, there can be no objection to its application before the winter-ploughing; but neither of these conditions is usual, and hence land intended for fallowing seldom receives any dung before winter. The reasons given above favour the application of the dung as early as the land is ready for it.

When lime and dung are both to be used upon a fallow, care must be taken not to apply them at the same time, otherwise, from their combination on the surface, ammonia will be set free and lost in the atmosphere. But, with due precaution, the two may be employed in the same season, not only without loss but with great advantage. The dung may generally be applied in a fresh state before the second spring-ploughing, after which the lime may be spread on the surface and worked into the soil. The combination of these fertilizers under the surface of the land will from the after-tillage increase the benefit derived from the employment of each separately. As the sun has great power at the season of the year when farmyard-manure is commonly spread on the fallows, the labour of the field should be so adjusted that the plough may follow the cart closely enough to bury the dung before it has lost its moisture.

Fallow-Crops.—The action of manure on these crops is very similar to that on fallows, so that the further consideration of its application resolves itself into a notice of the special requirements of each crop.

Mangold-Wurzel is one of the most valuable roots cultivated

upon stiff land. Three modes of applying farmyard manure are in use :—

1st. That of ridging the land, spreading the dung between the drills, and splitting the ridges in the autumn.

2nd. That of ridging the land in autumn, but delaying the application of manure till spring.

3rd. That of laying on the manure in the autumn, and either covering it by a deep ploughing, or by working it into the soil by the steam-power cultivators.

It may be urged, on behalf of the first method, that as an early sowing of the seed is important, and the difficulties of spring-tillage on a retentive soil in a wet season are considerable, nothing should be postponed until the spring except the actual sowing of the seed. On behalf of the second method, we may remark that the many demands on the stock of manure in the autumn, and the convenience of doing the carting to distant fields during the winter frosts, will frequently render its adoption desirable. The advocates of deep cultivation who are fortunate enough to have a grateful subsoil will generally adopt the third method, with perhaps as much eye to the permanent improvement of the soil as the immediate benefit of the root-crop. This method has the further advantage of effecting a more equal distribution of the manure throughout the soil, and in this respect we avoid an important defect of the ridge system ; for although by ploughing or cultivating across the ridges when the land is prepared for the succeeding crop, we may then obviate much of the future evil, still it should be more generally known that the quality and weight of the root-crop itself are often prejudicially influenced by the manure being retained within such narrow limits.

Swedes and Turnips.—The farmyard-manure used for these crops has very generally been applied to the land just before the last ploughing in spring ; but we have many modern instances where on strong soils an effort has been made to give the soil the benefit of an early admixture of long manure. In such case, the stubble having been cleaned during the autumn receives its allowance of dung before it is ploughed-up for the winter. This practice has been found to succeed so well that its extension is rapid upon stiff soils. Amongst the advantages which result are, the security of the manure from loss by bad management and the favourable action exerted upon the land—points to which we have already referred. To these we may add others which are of great importance. We have every reason to believe that, in proportion as we expose our soils—and clay soils more especially—to the action of the air and changes of temperature, in the same degree do we thereby develop their properties and bring

into action fertilising matter which would otherwise remain in the land in a dormant condition. This is equivalent to an addition of manure; for the materials of the soil which are thus rendered useful were previously existing in a condition unfit for the support of vegetation. The application of the dung before winter co-operates very powerfully in promoting this action, and we are at the same time adopting the surest plan for enabling the soil to absorb from the atmosphere some of the ammonia which is present there. So that not only do we thus preserve our manure from waste, but we enable the soil to develop and obtain further supplies of fertility; nor must we overlook the increased efficiency of the dung consequent upon its more complete distribution throughout the soil and the superior feeding qualities of the crop.

Potatoes.—The disease which has for so many years attacked this crop renders it necessary that the use of farmyard-manure be accompanied by some degree of caution. It has been observed that fermenting manures—such as dung—have a tendency to communicate decay to the plant. We have, therefore, two courses open to prevent the crop being thus injured:—1st, to substitute an artificial manure possessing a preservative character, or, at least, devoid of any unfavourable influence; or 2ndly, if farmyard-dung be employed, to counteract, as far as possible, its disposition to communicate decay. The latter point will be best attained by having the manure spread upon the land in the autumn and ploughed in before winter. In preparing the land for planting in the spring the manure will be well distributed through the soil; and thus, whilst the land is enriched by the dung, its natural tendency to promote decay will be diminished.

Cabbage.—In the growth of this crop the use of farmyard-manure is generally desirable, but circumstances render it advisable to apply the manure at the same time as the young plants are set out upon the land. Well-rotted dung is generally preferred, because the plant comes into full activity very soon after it is planted out. The cabbage is a gross feeder, and can scarcely have too much manure when the production of large autumn cabbage is desired; but if the crop is required for spring use it must not be forced with equal freedom. As in the case of swedes and turnips, so here also the slower-grown plant is the one which best withstands the severity of the winter-frosts and affords the best food in the spring. This must not lead us to deprive the cabbage intended for spring use of its usual supply, but rather to take measures for its distribution throughout the soil. In this way the keeping qualities of cabbage may be very materially increased.

Beans are generally sown upon land which has received a dressing of farmyard-dung. It is customary to spread the dung over the land, which being ploughed in, the seed is either drilled or dibbled. This crop luxuriates, under the influence of manure, to a far greater degree than other corn-bearing plants which we cultivate, and hence the regularity of the practice of using manure for it. In applying dung to a corn-crop there is frequently a danger of producing straw rather than corn; but with the bean this is very seldom the case. If the quality of the land is such that the dung produces haulm (or straw) to such an extent that the pods die off instead of filling with corn, we may find a simple remedy at hand by cutting off the tops of the beans with a large reaping-hook. The growth of the stalk being thus checked, the energies of the plant are at once directed to the production of seed, the blossoms cease to die off from want of nourishment and the pods are gradually developed. The position of the seed-pods in the bean gives it this advantage over other corn-crops.

Wheat, *Barley*, *Oats*.—The use of dung for these crops on stiff soils is by no means extensively carried out, although there are some neighbourhoods in which it is general. There is scarcely any practice which is apparently more contradictory. The employment of dung upon some soils insures the production of a good crop of corn, but upon other land it would with equal certainty destroy all our hopes of a satisfactory yield. When we are dealing with a rich clay, it is seldom that we can venture upon applying dung for corn, as it would cause a large growth of straw to the prejudice of the yield of grain. Other soils of a lower standard of fertility receive the manure with manifest advantage. We cannot, however, explain the differences observed by any comparative degrees of fertility which the soils may possess; and with our limited scientific knowledge upon the subject it is not desirable to speculate upon the controlling cause. Practically, we know that one farmer does not fear for his crop of corn, provided he can get straw enough; whilst on other land a good crop of corn may be confidently looked for, provided we do not get too much straw. It will be sufficient for distinguishing those soils upon which manure may be advantageously used if we say that, where the growth of the straw has to be encouraged, the application of dung may be practised; but on the other hand, when the soil is predisposed to yield a rank growth of straw, its use is seldom if ever safe. It is more than probable that by judiciously prepared artificial manures we shall, ere long, be able to supply our corn-crops with the nourishment required for the production of grain, without that danger of an

over-growth of straw, which we have to contend against in the use of dung. I am encouraged in this hope from the satisfactory results of an investigation on this subject which I am prosecuting at the present time.

When farmyard-manure is employed it is almost always succeeded by a wheat-crop, the use of dung for oats or barley being very exceptional. We shall subsequently have an opportunity of seeing, even more fully than has yet been explained, that when manure cannot be applied directly to the wheat-crop we may attain the desired result by allowing another crop to intervene. As an instance of this, I may mention the practice of applying dung for beans, or upon clovers when it cannot be used for wheat. This answers a double purpose: for it promotes the growth of crops which thrive under its direct action, and these crops leave the land enriched with materials required for the wheat.

Artificial Grasses.—Upon these crops the use of dung is generally attended with highly satisfactory results, and the extension of this practice is very desirable. Advisable as the application of dung in its early stages of fermentation may be for stiff soils, when it is to be ploughed into the ground, the case is different when it has to remain upon the surface. Dr. Voelcker has shown that in a well-fermented sample of farmyard-manure we have the ammonia present chiefly in the form of a humate which is readily dissolved by water but is not volatile, and therefore it is well prepared for being washed into the soil as soon as rain falls upon it, but is safe from being dispelled either by the heat of the sun or the passage of wind. For these and other reasons, the dung intended for our artificial grasses should always be carefully fermented, so that it may be rotten when spread upon the land. Upon stiff soils the autumn is the usual time of application. The valuable powers which clay soils possess for the preservation of the manure added to them renders a frequent application unnecessary, and thus we find a well-manured fallow or fallow-crop generally relied upon for carrying the land through its course of four or five years' tillage without additional help from the farmyard. If, however, the fallow-crop has been removed from the land, it becomes desirable and economical to apply some manure to the seeds in the manner stated. Another cause which has led to the extension of this practice is the opportunity it offers for drawing this bulky manure to the land during a period of comparative leisure, instead of delaying the cultivation for swedes by its use for the root-crop. In these instances artificial manure is entirely relied upon for the root-crop, and thereby a considerable saving of time and labour is effected during this urgent and critical seed-time.

The use of Dung upon Clay Soils.

Summary.

Time of Application.—In reviewing the remarks made upon the use of farmyard-manure on these soils, the general evidence indicates that great advantages result from the application of dung in the autumn and early winter months. So far as the arrangements of the farm permit, this appears to be desirable. On no condition should the dung which is to be ploughed under the soil be retained in the heap during the winter months, simply for the sake of fermenting it before its application. The dung will undergo the necessary changes *far more safely* in the soil than in the heap; therefore when there is an available supply of dung, and the opportunity for its application to the land, it will be advisable to allow the soil to have it in its own custody with as little delay as possible. This will not justify us in restricting its use to the fall of the year, although it is undoubtedly the best time. The spring demand will still continue for some crops as already pointed out, but a preference will, as far as possible, be given to the use of dung in the autumn and early winter months.

Crops.—The fallows, fallow crops, and artificial grasses, take the precedence of other crops for receiving the dung which is to be applied to the land; and, under the variations of soil and systems of husbandry already pointed out, each of these in its turn receives the preference. There are certain manifest advantages in using dung for these crops, because under good management they do not impoverish the farm, but rather act as accumulators of fertility. Although the application of dung for corn-crops answers exceedingly well in some districts, there is reason to believe that its use upon the preceding crop of clover will be attended with even better results. The use of dung for corn is quite exceptional; and it is probable that under improved management it will become even more uncommon than at the present time.

The use of Dung upon Light Soils, such as Sands and Sandy Loams.

Fodder-Crops.—There is a great diversity of practice in the use of dung for these crops, arising from the difficulties which attend its employment rather than from the want of a desire to have its assistance in promoting their growth. The use of farm-yard-manure very much favours the produce of these crops both in quantity and early maturity. The Trifolium (Trifolium incarnatum) is the only apparent exception; but this is more to be accounted for from the plant requiring a firm seed-bed than from

any other cause, for the existence of fertilising matter in the soil is as necessary for promoting the growth of this crop as any other. The chief reason for the use of dung not being more general, is the delay which its application would cause at the time of sowing. If there be sufficient manure and labour available to permit a moderate dressing of dung to be laid upon the land without delaying the time of sowing, its employment is decidedly advisable. A doubt often arises, when the supply of dung for roots is limited, as to the relative advantages of using manure for the spring feed, or of keeping it entirely for the root-crop; but there is a very general opinion entertained that the turnip crop is decidedly improved by the use of a portion of the dung upon the spring crop which precedes it.

These crops being consumed upon the ground, the soil again receives the chief portion of the materials previously drawn from the land; but their services do not end here, for during life they have gathered stores of fertility not only from the soil, but from the atmosphere, and the latter consequently become an addition to the soil gained by the vital energies of the crop. The more such a crop luxuriates, the greater the addition thus obtained, and consequently a liberal use of manure is productive of the best results. It is clearly, therefore, no loss to the root-crop, if for this object it is deprived of some portion of the dung usually allotted to it; because the spring food produced, by being consumed on the land, returns to it nearly all it has drawn from the manure, together with an increase the land could not otherwise have had.

The usual practice of applying manure shows a marked difference in the quantity applied for these crops as compared with what would be used for roots, as from one-third to one-half of the entire quantity is seldom exceeded. This may need an explanation, because it appears inconsistent with my preceding remarks. This decrease in the quantity is not because the crop would not have been benefited by more manure, but rather because these sandy soils are generally deficient in their powers of preserving manure. For this reason they quickly lose their fertility and need fresh supplies, and hence they are called hungry soils. Thus a moderate application of dung is made, which shall be only as much as the plant can use before the passage of water through the soil causes material loss. The less the power of any soil to retain manure, the greater the care required to supply a more moderate quantity. It is for this reason that many farmers of sandy land do not apply any dung to these crops, and others do not apply their manure until the spring, the growth during the autumn and winter being so exceedingly slow, that by the time the plant becomes aroused into energy by the return of spring,

the manure applied would have been washed out of the land. Unlike the occupiers of retentive clays, the farmer of sandy land has to contend against a wasteful soil, which requires him to be discreet in the use of manure. How far it is an economical procedure to overcome this prejudicial character in our light soils by the use of clay or marl, is a matter of serious importance to the occupants of such land.

Root-Crops.—Upon our sands the use of dung for these crops is not generally in favour, but in the same degree as the land becomes more loamy in its character, or, I might say, as the proportion of clayey matter in the soil increases, so the application of dung for roots becomes increasingly desirable. The reason scarcely needs explanation, as it is manifestly dependent upon the preservative powers of the land. We also find that the condition of the manure varies in the same manner; for those soils which have the least powers for retaining manure require it in the most decomposed condition—in fact, ready for immediate use by the growing crop. In the case of clays and clayey loams, we have seen that great advantage resulted from using the dung as fresh as possible, because the decay in the soil proceeded without loss, and in a more advantageous manner. In our sandy soils, it is directly the reverse; the slow fermentation would here be attended with considerable sacrifice, and consequently the manure must be prepared by a careful fermentation before it is added to the land. As the soil approximates more and more closely to a loam, so may the manure be advantageously applied in a less decomposed condition. The rule previously named still holds good—that, *so far as the preservative powers of the soil will permit*, the fermentation will be advantageously conducted beneath the soil in preference to being carried on in a manure-heap.

Apart from a consideration of the fertilising ingredients of the manure, we have other reasons for carrying out this rule which are forced upon us by its mechanical influence upon the soil. The sandy soils, from their want of adhesive power, require compression rather than any increase of their loose character; for although plants require a freedom in the soil for the extension of their roots, still when there is not sufficient firmness in the land to enable them to maintain a steady attachment to it, they cannot flourish. Growth is most luxuriant when these opposing tendencies are nicely balanced, as, for example, in our loamy soils, which possess in a sufficient degree the superior qualities both of the clayey and sandy soils. Our efforts are therefore directed to render our clay soils less adhesive, but to make our sandy soils more so. Whilst, therefore, we take advantage of the rigid character of long dung to keep our clay soils open, we find it advantageous to overcome this influence in the dung intended for sandy soils. This is best done by a well-conducted fermenta-

tion, for we can thus reduce the dung (if so required) even to a soapy condition, in which it can be dug by a spade, and not in the least degree capable of rendering the soil more porous and open. The following rule (which practically corresponds with the former) may be given to indicate the manner in which we should regulate the mechanical condition of the dung according to the requirements of the land :—That in the same degree as the proportion of clay in the soil is found to increase, so may the dung be most advantageously applied to the land in a less fermented state ; and, conversely, as the land becomes more sandy, so the dung should be applied in a more rotten condition.

Artificial Grasses.—These are exceedingly valuable to the cultivator of sandy land, and the application of dung is here found very desirable. There are two periods in their growth when the manure is applied, varying according to the custom of the farm. When the employment of farmyard-manure for the root-crop is found to be attended by a loss of its fertilising constituents, it is desirable to apply it to the artificial grasses. This is attended with many advantages, which are worthy of more general acceptance. In the use of dung for young seeds, it should be applied after it has been been carefully rotted in the heap, and it should be spread on the land either in the autumn or following spring. Early in the autumn is certainly the best time, because then the plant has the opportunity of making a good growth and establishing itself in the ground by a firm root before the winter stops its progress. It has thus prepared itself for a vigorous growth in the succeeding season, and this is much more important than is generally supposed.

The use of dung for seeds upon sandy land has peculiar advantages, because we thereby enlist the powers of vegetation to compensate in some degree for the absence of power in the soil to retain manure. In adding dung to the land for a root-crop, a long time necessarily elapses before the crop attains to a state in which growth is rapid, or in which it can quickly make use of the manure. All this time the manure is suffering waste in the soil. When dung is applied to the young seeds, we have a crop *ready* to take advantage of it, and possessing powers of rapid growth by which the materials of the manure are, to a great extent, taken up at once by the crop, which consequently makes an unusually rapid growth. This growth above-ground is accompanied by an equally rapid development of the root beneath the surface, which becomes a source of power for promoting the growth of the following season, and also serves to keep the manure from passing into the porous soil beneath. These are advantages of no ordinary character, which are thus placed within the reach of the cultivator of sandy land.

Many persons are accustomed to feed their young seeds before

winter, but this is decidedly objectionable. It is argued that if not thus eaten, much of the herbage will perish uselessly, and therefore it may as well be eaten as not. Such an argument is fallacious; for if you could only consume that which would otherwise fall, you would still be but a small gainer. You would gain a certain quantity of food, but you lose a certain amount of fertility from the land, for the manure does not fully compensate the land for what is consumed, and here the profit would end. The loss, however, is *very* much greater in consuming the clovers (and especially if it is done by sheep, and this is the usual stock), for much more is fed off than would have fallen. The growing centres of the plant are damaged, the growth of the crop is held in check, and as a necessary consequence *the extension of the root is equally influenced.* As a result of this practice we often find the land, which ought to have had a good crop and a regular plant, has failed in places, and not realised the expectations formed from the appearance in the autumn. The healthy and luxuriant growth resulting from the early application of well-rotted dung, may strongly tempt the farmer to stock his seeds in the autumn; but if he yields to this temptation, the promise of the future will be sacrificed for a very inadequate immediate advantage.*

The second mode of applying dung to artificial grasses is at a later period of their growth, viz., during the summer preceding their being broken up for corn. But, as in this case the benefit of the corn-crop is the primary object in view, a consideration of this practice belongs rather to the next division of our subject.

Corn-Crops.—The porosity of much of our light land renders it advisable that the crop which is generally looked upon as the chief source of profit should have a preferential claim upon the manure. Consequently, we see it customary on some farms to apply dung for the corn-crop before ploughing the land for wheat. Taking the best example of farming, we find that when the land is sandy it is considered desirable to apply the dung some time before the ground is ploughed. If the manure were simply buried in the land, the slow growth of wheat would not enable it to take full advantage of its fertilising properties ere it would be washed beyond its reach. The case is exactly the same as that of the root-crop already named, and the necessity for an intervening agency is equally great. This our improved practice has supplied; and hence it is found desirable to spread the manure intended for the wheat, in a well-rotten condition,

* This principle of action, which is sound as a general rule, will hardly be violated if the flockmaster runs his hoggets over the layers on sandy soils, with a view to consolidating the surface, so long as they only pick the top of the feed, and that before frost sets in.—P. H. F.

some six or eight weeks before the clover-ley is going to be ploughed up. This encourages a rapid growth of the plant, both above and below the ground, by which the manure is secured—part being converted into vegetable matter, and the residue preserved by the organic matter thus produced. In this way the manure is preserved for the use of the crop, notwithstanding the deficiency of a preserving power in the soil.*

The Use of Dung upon Sandy Soils.

Summary.

Crop.—I consider we are justified in stating that as the proportion of sand in the land increases, so does it become more important to apply the dung upon the artificial grasses, in preference to its more direct intermixture with the soil for roots or corn. As the soil becomes more tenacious by the admixture of clay, and thus becomes either a sandy loam or a loamy soil, we may exercise greater freedom, and plough the dung into the land for the root-crop. So long as the soil has not sufficient tenacity of character to preserve the manure for the required period, it is clearly advisable to accept the aid offered by the artificial grasses, because they constitute the best guardianship which can be obtained under the circumstances. In addition to this valuable property possessed by these grasses, there is no crop which is better prepared to make a rapid growth, or which in its growth abstracts from the air more valuable fertilising matter. The latter property is not to be overlooked, for we have every reason to believe that the artificial grasses have a special power of deriving nutriment from the atmosphere as well as from the soil, and on this ground are worthy of our especial attention.

Time of Application.—Whether the dung should be applied to

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* After repeated experiments on the application of manure, in November, in April, and in July, I have come to the conclusion that July is the earliest time when this work can be done with advantage *on sandy soils*, even when the crop is not mown. I have laid on first-rate London manure in November, and found but little good done to the spring-feed, and still less to the corn-crop following. I find the action of manure taken fresh from the yards in July so satisfactory that I feel no inducement whatever to keep back the more costly well-rotted manure for this purpose.

With the uncertainty how the season may alternate between showers and a powerful sunshine, I cannot wish the ammonia in the dung to be in a forward state of development. If the supply of food is small at first, but increasing as the herbage grows round, through and over the dung, waste will be most effectually prevented.

If a small admixture of cow-grass and Dutch clover has been sown among the grasses, July is the season at which the development of these plants can be best promoted—plants which, besides producing superior herbage, contribute by the net-work of their roots to the formation of that compact turf so valuable on these soils. The grasses run away with the chief part of the nutriment if the manure is applied in spring. In a word, with soils that have no *bottom* a *waiting race* is the safest.—P. H. F

the seeds when young, or shortly before ploughing for corn, must depend on the variations of soil, climate, and management. Under a liberal treatment and judicious forbearance in stocking the land, the earlier application will generally be the preferable with especial regard either to an abundant supply of sheep-food or to ample crops of corn, but the result will turn upon liberal management. If, for example, the seeds having made a good growth are twice mown, it is very clear that this light land will not be in as good a position for growing a crop of corn as if the dung had been applied at a later period. The total influence exerted by the manure may under these circumstances be as large as is attainable, but it will not have been concentrated for the special advantage of the following corn-crop.

In these remarks I have advisedly paid particular attention to those soils which are characterised by the extremes of sand and clay, because as we have soils of every shade of character, the modification of any general rule must inevitably be left to the discretion of the occupier in each particular instance. I have also said but little as to the quantity to be applied. It has been shown by chemical investigation that the most powerful fertilising ingredients constitute but a very small proportion of the bulk of farmyard-manure—so much so, as seldom to exceed 50 lbs. in a ton. Small as this proportion may be, it is also very liable to waste to such an extent that Dr. Voelcker has shown * that under bad management "two-thirds of the manure was wasted, and only one-third left behind for use." Since, therefore, the quantity of fertilising matter depends much more on the food consumed by the stock and the general management of the manure than on the quantity applied, within ordinary limits we cannot satisfactorily indicate the right number of loads, or even the weight that should be applied, when the body to be used is so inconstant in character and composition. Yet that there are definite limits to the economical application of manure was clearly shown by some interesting experiments conducted by the late Mr. Pusey and reported in the Journal of this Society.† A field prepared for mangold-wurzel and manured in the following manner gave these results :—

26 loads of dung produced	28½ tons per acre.
13 loads of dung produced	27½ ,,
Land without manure	15½ ,,

Here we observe that whilst the first 13 loads of dung produced an increase of 12 tons of roots, a further addition of 13 loads only produced 1 ton of roots. At this point the employment of artificial manure comes in with peculiar value so as to increase the produce of the land profitably when it is beyond the

* Journal of Royal Agricultural Society, vol. xvii. † Vol. vi. 530.

power of farmyard-dung to do so. Thus we find in the same experiment that when artificial manure was employed instead of the extra 13 loads of dung, there was a further increased yield of 8½ tons per acre, whilst, as stated above, the increase from the use of the extra dung was only 1 ton.

Class II.—Animal Manures without Straw.

Although manures of this class are, generally speaking, deposited upon the land by the animals themselves, yet even here we can exercise a more important control than is at first sight apparent. This class includes all manures produced on the farm by the consumption of the growing crops, and therefore comprises such as are produced by grazing and folding. In connection with the grazing of cattle and horses, little can be done but to knock about and spread their droppings—a work which will more than repay the cost of the labour of the old man or boy so employed, by obviating the growth of rank and sour herbage, which the stock will refuse to eat. By the practice of folding we can very completely regulate the application of manure. As a rule, it is only applied to sheep, although in some exceptional cases it has been adopted for horned stock and for pigs. Even sheep-folding has too often been restricted to the consumption of the turnip-crop on the land; but I shall endeavour to show that still greater advantages have been derived from the extension of this system to other crops.

By a regular division of the field into folds we gain the very important advantage of *an equal distribution of the manure* over the land. Unless the field is thus apportioned off, the sheep will resort to their favourite lairs, and these spots will receive too much manure, whilst other parts of the field will have scarcely any. The corn is consequently too rank in the former places, and is likely to be laid; but on the latter parts the crop is not strong enough. The regular distribution of the manure favours a more even growth of the corn-crop which is decidedly advantageous.

It is only right that in restricting sheep from resorting to their favourite lairs we should notice why they give such a decided preference to these spots, such preference being certainly the result of an instinctive guidance; and therefore it were well to be assured that in counteracting this natural desire we provide an adequate substitute. Two conditions generally influence the preference shown by sheep—shelter and dryness of soil. The former can be readily supplied by the use of light hurdles covered with thin boarding or by wattled flakes, both of which can be shifted as easily as ordinary hurdles. If it be intended to have a more permanent fold, a double row of hurdles stuffed with straw gives even more shelter; but for all ordinary purposes

either of the former will answer every purpose. Their general use will be found extremely remunerative; for, whether the flock may be for breeding or feeding, the importance of one or two sides of each fold being thus sheltered will be very great. The dryness of the land is not so directly under our control; for, although drainage will do much to improve it in this respect, still much more than this is in many cases required before the land becomes sound for folding; and such land will generally render large folds necessary. If we prevent the flock selecting its own lair at night, it is alike our duty and our interest to provide artificially that which they seek to secure naturally.

The practice of folding not only influences the distribution of the manure, but in some cases—as, for instance, with the clovers and other growing crops—*it increases the quantity* produced. As each portion of the field is successively folded off and cleared of stock, an immediate and uninterrupted growth takes place; whereas, if the sheep have freedom to run over the entire field, they continue eating the youngest growth in preference to that which is older, and which constitutes by far the greater portion of the feed. It is needless to say that this mode of eating the crop must prejudice the growth during the time the sheep are on the land. In the one case the growth is checked for a day or two; in the other probably for four or five weeks, or as long as the crop in the field is being eaten. In consequence of the growth of herbage being more scanty, a smaller quantity of manure must be produced. This deficiency of growth is necessarily accompanied by a decreased absorption of fertilising matter from the atmosphere, which is one of the most valuable properties possessed by our clovers. The prejudicial influence resulting from the ordinary mode of feeding our crops of clover also has an important influence upon the quantity of stock which the land is capable of maintaining. The higher the productive power of the land, the greater will be the difference in the number of stock which can be carried under the two systems. In most cases one-half more stock can be kept equally well, but in other instances it has been more than doubled.

A further advantage may be realised by taking advantage of the fact that plants are most nutritious just before attaining their maturity. If the supply of keep be so regulated that advantage can be taken of this knowledge, not only will the stock thrive better, but the manure made by them will be of superior quality. This system is well carried out by Mr. Hope, of Fenton Barns, whose practice is to cut his first crop of clover for hay, and to let his second growth come almost to maturity, and then feed in the manner spoken of. His experience is, that land so treated is as rich in condition as when pastured all the season without the removal of a crop of hay. This is no solitary testimony, and

therefore I feel justified in stating that, under a judicious system of folding, we may safely anticipate an equal distribution of the manure, an increase in the number of stock which can be kept, the production of more manure, a considerable improvement in the quality of the food grown, and consequently a more valuable manure.

Another mode of enriching the land is by the system of night-folding — a practice which is extensively and advantageously carried out in some of the south and south-eastern counties of England. During the day the flocks graze over the downs, commons, stubbles, or leys, and return at night to be folded upon land intended for corn or sometimes for roots. In some cases they are brought back to consume vetches, mustard, or roots; but in either case the tillage-land gains manure at the cost of the rougher grazing-land. The shepherd should always take care to move his flock about gently in the fold for some time before turning them out for the day, as the sheep thus deposit their manure where it is wanted.

Another form in which we have to deal with animal manures without straw is met with when stock are kept upon open sparred floors without bedding. Some dry material—such as peat charcoal, burnt clay, peat ashes, or the ashes of weeds—is generally mixed with such manure to facilitate its application by means of the drill. Some have imagined that the manure is injured by being mixed with fresh ashes: this may have arisen from the caustic condition of the alkalies contained in the ashes; but by exposure of the ashes to the air in a dry shed this would soon be overcome. This manure, being of very soluble character, is best adapted for application on light land, in moderate quantity, and in close connection with the seed.

Liquid-Manure.

This constitutes the third variety of animal manure without straw. It consists of the liquid excrements of the stock intermixed with more or less water; but it is often distinguished as tank-water from the receptacles in which it is collected. So far as these tanks act as reservoirs for the drainage of liquid which would otherwise be lost, their value is unquestionable; and there is scarcely a farm upon which the system may not be adopted with advantage. It has, however, in many cases been carried out to such an injurious extent, that it becomes important that some line should be drawn to indicate the limits of successful application. The rule upon which we may safely base our proceedings is, that it is not desirable to separate the liquid from the solid portions of the manure where they can be used together. In the various modifications of the box or pit system, by which the liquid and solid portions of the manure are kept together, we

find that combination which is most advantageous for the general purposes of vegetation. In this combined form we have a manure which more completely supplies the wants of the growing plant than either the solid or the liquid can separately accomplish. After the food of the animal has been digested and passed into the intestines to yield to the animal system the nutriment it contains, the portion which remains unabsorbed constitutes the solid excrement of the animal. This residuum will consequently be deficient in such substances as the alkalies and phosphates, which after being taken up into the system are again to a certain extent voided in the urine. The food of the animal in its original state may be taken as the type of the perfect plant, which has been divided by the processes of animal life into two distinct portions; and it is only when these are re-combined that the manure becomes fully adapted for the support of vegetation.

Under certain circumstances it does not appear advisable to carry out the box or pit system; and thus, by the adoption of stalls, &c., we have the natural separation of the solid and liquid excrements to a great extent maintained. The former is generally removed to the manure-pit, whilst the latter runs away to the tank. The best mode of using this liquid manure is a disputed point; but various reasons induce me to think that we cannot do better than employ it in conjunction with the solid matter from which it had been separated. The solid manure on being removed from the animal soon undergoes a fermentation, that it may again assume a form adapted to the support of vegetable life. The value of the product depends on this process being duly regulated; and the presence of moisture is indispensable for preventing a too rapid or violent action. To this end what liquid can be as beneficially applied as that which will restore those elements of fertility which have passed away from it into the urine, at the same time that it checks undue heating. By the aid of a pump and hose the tank-water can be easily distributed over the fermenting manure, which should be moderately compressed, but not so tightly as to prevent the passage of the liquid through its mass. Many manure-pits are constructed so that they may drain into the tank. This is a good plan, for it enables the liquid to be freely used without fear of adding too much to the heap. I am a decided advocate for the use of the liquid-manure with the dung of the farm, for I believe that in their combined use both act with increased advantage.

The adoption of this mode of using the liquid-manure will, under a careful course of management, remove the necessity for further question as to the use of this fertiliser; but for those cases in which it is allowed to become intermixed with other water, or in which it is wished to apply it to the land in a

separate condition, further comment is necessary. We have been gradually brought to the conclusion, that although liquid-manure does possess valuable fertilising powers, yet these generally exist in such a diffused state that the cost of application exceeds its value, and hence it is a very generally accepted rule that the distribution must be accomplished by its own power of gravitation, or under some cheap pressure. When liquid-manure can be distributed over the land in an inexpensive manner, it becomes important to consider the influence exerted by its dilution. In the general practice of irrigation we observe the fertilising influence of the ingredients, thus added to the land, very much increased in consequence of their being presented to the roots of the herbage in a very diluted form—a condition in which it is especially favourable for the requirements of the plant. Nor are we without evidence that the action of any given quantity of liquid-manure may in like manner be increased by a similar dilution; but in the practical application of this experience we have first to consider the cost of distribution, and then increase the dilution in proportion to the porosity of the land.

This addition of water simply effects a mechanical change in the liquid-manure, but there are chemical changes which alter its composition, and which must not be overlooked. A somewhat similar fermentation takes place in liquid-manure to what we observe in farmyard-dung, whereby we have ammoniacal salts formed in it. It has been doubted whether this change should be allowed to take place before or after its application to the land. If the liquid-manure is to be applied to a light soil, it will be desirable for this change to take place before it is used, because we cannot have it too well prepared for at once promoting vegetable growth. It may not be as necessary when applied to soils containing an admixture of clay; for, although we are not at present in a position to say that the same production of ammonia will take place in the soil, still we have reason to believe that no direct loss will ensue. Hitherto the evidence of experience has been strongly in favour of keeping the liquid-manure in the tank until it has fermented, but this experience, it must be added, has been chiefly derived from trials on light soils. It is possible that future trials may show, that upon stronger and more adhesive soils, the manure may be used fresh with greater advantage; but at present the fermentation before distribution is generally accepted as the best plan.

We have next to notice the crops upon which its employment has been successful. Here we have conclusive evidence that upon our natural and artificial grasses its use has been most beneficial. The Italian rye-grass has produced under its stimu-

lating action crops of unparalleled weight and quality; and upon grass land most satisfactory results have been produced. It has also been applied to corn-crops successfully, but great care is here necessary, for if the land is naturally disposed to a large growth of straw, there will be considerable danger in its use. There are many soils (to which I have before made reference) from which there is sure to be a good yield of corn, provided there is straw enough; upon such as these this straw-producing manure will be suitable. It must not be looked upon as a direct stimulant for increasing the production of corn (for its immediate tendency is rather to encourage a growth of grassy herbage, and therefore of straw), but it may be taken advantage of indirectly to encourage the production of corn as in the instance named.

The best time for applying liquid-manure is during the period of the crop's growth, and especially in the earliest stages. Moisture and nourishment added to the land during either of those months of the year in which the climate favours a rapid growth, may be relied upon as being valuable assistance for increasing the crop. The more active the disposition for growth the more welcome will these supplies prove, and consequently we find the use of liquid-manure (if properly diluted) is most efficacious in the summer, when the energies of the plant are most active, the supply of moisture most grateful, and the nourishment of the manure most needed for the structure of the growing crop. Some discretion, however, is necessary in selecting the proper time for its application. If we observe the natural supplies of moisture in the form of rain, we see the plant in some degree prepared for it, by a moist atmosphere, and a cloudy sky: hence, in applying liquid-manure, we should as far as possible imitate this example, and avoid the scorching rays of the sun by reserving our supply until the cool and moist hours of evening are approaching. This precaution is less necessary when the ground has just been mown, but even then it is desirable. Although, as I have stated, liquid-manure may be applied to the best advantage when the powers of vegetation are in full activity, its employment in the winter may not always be objectionable if there is an abundant supply, but it must be remembered that it is not every soil which can derive benefit from its use. Sandy soils, for example, which have but weak powers for the preservation of manure, derive little advantage except during the period of vegetation, but this objection does not apply to soils of a more retentive character.

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XVIII.—*On the Chemical Composition and Commercial Value of Norwegian Apatite, Spanish Phosphorite, Coprolites, and other Phosphatic Materials used in England for Agricultural Purposes.* By Dr. AUGUSTUS VOELCKER.

WHEN superphosphate of lime was first introduced into agriculture, it was exclusively prepared from raw or boiled bones. It was then sold more frequently under the name of dissolved bones and of German compost than under that of superphosphate. Animal black or bone-charcoal, in the shape of refuse from sugar-refineries, and South-American bone-ash, were soon recognised as valuable materials for the production of artificial manures. In some respects these refuse matters were found even superior to bones for making superphosphate. They are now eagerly bought up by manure-merchants, and extensively employed in the manufacture of phosphatic and other artificial manures.

The timely discovery of fossil bones and phosphatic nodules in the Suffolk crag, and of chalk coprolites further provided an abundant source of phosphates in our own country, to meet the yearly increasing demand for those artificials which owe their efficacy principally to the valuable phosphate of lime which they contain. But raw and boiled bones, animal black, South-American bone-ash, Suffolk and Cambridgeshire coprolites, are not the only materials that are employed at the present time in the manufacture of superphosphate. Apatite from Norway, phosphorite from Estramadura, Sombrero phosphate or Crust guano, American phosphates of various kinds, and certain phosphatic guanos, are likewise imported into England in considerable quantities, and converted, by means of sulphuric acid, into valuable manures, to the mutual benefit of producer and consumer.

Manure manufactories are now spread over the length and breadth of the country, and in all these works the staple product, under whatsoever name it may be sent out, is in reality, in nine cases out of ten, superphosphate of lime. The consumption of this kind of manure, large as it is at present, is increasing every year, and is likely to increase for years to come. It must not be supposed that the large demand for phosphatic manures is the result of extraordinary exertions on the part of the manure-merchants, or is due to a prevailing, and it may be passing, faith in this class of fertilizers. It rests on the universal experience of farmers that no description of manure repays a judicious outlay so well as this, especially when applied to root-crops. Whilst other kinds of fertilizers have been tried on a large scale,

and not been found to realize the expectations raised, superphosphate and similar phosphatic manures have maintained a firm hold in the good opinion of the agriculturist. Far be it from me to undervalue the great utility of Peruvian guano, nitrate of soda, and nitrogenous manures. These are excellent fertilizers for wheat and corn-crops in general; but considering the circumstance that a good root-crop lies at the very foundation of an improved system of agriculture, and that this crop is more signally benefited by phosphates than by any other fertilizing constituent, I believe the farmer is right in attaching the highest importance to phosphatic manures. At all events, he has found by experience that in most cases in which it is deemed desirable to make up a deficiency of yard-manure, it pays better to purchase superphosphate and similar manures for the root-crop than to buy nitrogenous manures for the white crops.

It is certainly remarkable that whilst the direct application to the land of nitrogenous constituents has been by some considered useful only in special cases, and by others superfluous or even undesirable, nobody has ever expressed any doubt as regards the economical benefits that generally attend the use of phosphoric acid; whilst nitrogenous manures in the case of some crops, such as peas and beans and clover, have been found even to be injurious, every kind of produce has been more or less benefited by the direct application of phosphates in an available condition. Whereas ammoniacal salts and other purely nitrogenous fertilizers, when applied alone to swedes, turnips, and probably other root-crops, have, generally speaking, failed to increase the produce,—the exclusive use of soluble phosphates has, in almost every instance, largely benefited these crops.

Again, we can increase the proportion of nitrogenous constituents in the soil by other means than by their direct application in the shape of manure. Thus, after a good crop of clover, I have found that the amount of nitrogenous matters in the soil is very much larger than it was before the clover. If, therefore, we can succeed in growing a good crop of clover, we at the same time enrich the land with nitrogenous matters, and provide for the succeeding white crop that kind of food for which it appears to be specially grateful. The fact that a good crop of wheat may be confidently anticipated after a good clover-crop is generally admitted; the power of the clover to accumulate nitrogenous matter in the soil, which explains this result, may not be as fully recognised. Moreover, whilst few soils contain more than traces of phosphoric acid, nearly every kind of agricultural produce contains this acid in very large and often preponderating proportions; its presence being further required to furnish the phosphorus which largely enters into the composition of albu-

men, gluten, legumine, and indeed all albuminous compounds. How large then is the demand for those constituents which even the best soils supply but in scanty proportions! We can thus understand why their direct supply in an available condition is of more vital importance to our cultivated crops than that of any other fertilizing substance.

Generally speaking, phosphatic manures produce a more marked effect upon root-crops than upon cereals. At one time it was supposed that root-crops removed more phosphoric acid from the soil than white crops, and on that account required to be more abundantly supplied with phosphates. But this explanation is as little correct as all others in which no account is taken of the respective periods of vegetation of green and white crops, and the different mode in which these crops take up the food at their command in the soil. The roots of swedes and turnips, unlike the deep penetrating roots of the wheat-plant, with their numerous fibriles, feed, comparatively speaking, upon a small portion of the cultivated soil, and their whole period of vegetation is very much shorter than that of our cereals, especially that of wheat. Whilst the wheat-plant is thus enabled to search for proper food in a considerable depth of soil, and by degrees accumulates in its organism the requisite amount of phosphoric acid which is distributed in small quantities in a large mass of soil, turnips, swedes, and mangolds, in consequence of the peculiarities of their growth, do not find at their disposal available phosphoric acid in sufficient quantity to supply that weight of bulbs which we now look for in average seasons. Hence it is that manures, rich in soluble phosphates, produce such a striking effect on root-crops, no matter what the character of the soil may be on which they are grown.

Although superphosphate and bone-dust do not generally benefit wheat to the same extent as turnips, these and other phosphatic manures are very efficacious when cereals are grown on light sandy soils or land naturally very poor in phosphoric acid. I do not purpose to institute at present a minute inquiry into the relative utility of the various organic and mineral constituents which constitute the food of plants, nor to extend the preceding observations. They are merely offered as suggestions which to some extent, at least, explain the fact that the sale of phosphatic manures has been steadily increasing from year to year, and has now assumed gigantic dimensions.

The supply of bones is totally inadequate to meet the present large demand for superphosphate and similar fertilizers. It is fortunate, therefore, that England possesses an abundant source of phosphates in the extensive Suffolk and Cambridgeshire coprolite deposits, and that the enterprising character of English-

men renders available for the use of farmers the discoveries of phosphatic deposits in Norway, Spain, America, and other countries. The composition of most of the phosphatic materials which are used at the present time by manure-manufacturers in England has been carefully ascertained; but many of the analyses are scattered in scientific journals, and not readily accessible to the agriculturist or manufacturer. Several phosphatic materials again have only recently been imported into England, and of these no trustworthy analyses have been as yet published. Of others we possess careful analyses made from picked specimens, but no published account of the composition of the materials in the state in which they actually occur in commerce. I propose, therefore, to give an account of all the more important phosphatic materials now in use, and briefly to describe their general appearance and more characteristic physical properties, stating the localities where they are found, their composition as ascertained by me, and some particulars which may be of interest or practical importance either to the farmer or to the maker of artificial manures. The following is a list of the substances of which I shall treat:—

1. Norwegian apatite.
2. Spanish phosphorite.
3. Cambridgeshire coprolites.
4. Suffolk coprolites.
5. American phosphate (Maracaibo guano).
6. Sombrero, or Crust-guano.
7. Kooria Mooria guano.
8. Other phosphatic guanos.
9. South-American bone-ash.
10. Animal-black, or bone-charcoal.
11. Bones.

There are a few other phosphatic materials which now and then find their way into commerce, but to these I shall either not refer at all or only incidentally.

1. Norwegian Apatite.

Apatite, a hard and often well-crystallised mineral, chiefly composed of phosphoric acid and lime, is found in this country in Devonshire, Cornwall, and Scotland, but not as yet in sufficient quantity to allow of its being collected for technical purposes. In America it is found imbedded in granite at Baltimore, in gneiss at Germantown, in mica-slate in West Greenland; in granite at Milford Mills, near Newhaven, Connecticut; at Topsham, in Maine, in granite, and in various other localities mentioned in detail in Dana's 'Mineralogie.' On the Continent

it is found in several places in the Tyrol and Switzerland, also in Bohemia, Saxony, Bavaria, Sweden, and Norway. Most commonly it occurs in thin seams, imbedded in crystalline or volcanic rocks, but seldom in sufficient quantity to repay the cost of working.

Mineralogists distinguish several varieties of apatite. Some specimens are regular crystals, others crystalline, others foliated or conchoidal. The colour varies as much as its crystalline structure; but, generally speaking, apatite has a light green or a reddish colour. The apatite which at present is imported into England from Norway is found chiefly at Krageroe.

Two specimens of red-coloured apatite furnished, on analysis, the following results:—

	No. 1.	No. 2.
Hygroscopic water	·43	·43
Water of combination	·40	·40
*Phosphoric acid	41·88	41·74
Lime	53·45	54·12
†Chloride of calcium	1·61	1·61
Magnesia	..	·20
Phosphate of iron and alumina	·66	·45
Insoluble siliceous matter	1·24	·97
Alkalies	..	·30
	99·67	100·22
* Equal to tribasic phosphate of lime (bone-earth)	90·74	90·44
† Containing chlorine	1·03	1·03

These specimens had a bright red colour like ironstone, and yet they contained but very little oxide of iron. Two other samples of very light green-coloured, almost white, apatite from Krageroe, were found to contain:—

	No. 1.	No. 2.
Hygroscopic water	·19	·298
Water of combination	·23	·198
*Phosphoric acid	41·25	42·28
Lime	50·62	53·35
†Chloride of calcium	6·41	2·16
Oxide of iron	·29	·92 (Oxide of iron and Alumina)
Alumina	·38	
Potash	·04	..
Soda	·13	..
Insoluble siliceous matter	·82	·99
	100·36	100·196
* Equal to tribasic phosphate of lime (bone-earth)	89·37	91·60
† Containing chlorine	4·09	1·38

It will be seen that these samples of Norwegian apatite contain a very high percentage of phosphate of lime, only a small amount of foreign impurities, and no carbonate of lime whatever. They are also perfectly free from fluorine, which is present in

most other varieties of apatite. The amount of chloride of calcium, I find, varies from 2·16 to 6·41 per cent. in pieces chipped off the same block, showing that large blocks are not always uniform in their composition.

The preceding analyses were made some years ago. Quite recently I analysed a sample of ground Norwegian apatite, which yielded the following results:—

Moisture (driven off at 212° F.)	·24
Water of combination	·66
Lime	45·12
*Chloride of calcium	2·53
Magnesia	·74
Oxide of iron	1·29
Alumina	1·53
Potash	·36
Sulphuric acid	·29
†Phosphoric acid	35·69
Insoluble siliceous matter	11·62
	100·07

* Containing chlorine	1·62
† Equal to tribasic phosphate of lime (3 Ca O, P O_5 = bone-earth)	77·33

This sample, like all those from Krageroe in Norway which I have hitherto examined, does not contain a trace of fluorine. It is likewise free from carbonate of lime, but contains more siliceous matter, and also more oxide of iron and alumina than the cargoes imported from the same locality in former years. These impurities necessarily reduce the percentage of phosphate of lime, which, however, is still very considerable in the last-mentioned sample.

I have already noticed that the composition of the unground mineral is not quite uniform. In some pieces fragments of quartz, hornblende, and other foreign minerals, can be seen with the naked eye. In order, therefore, not to be misled by the analyses of picked specimens, it is necessary to reduce to a fine powder a considerable quantity of the mineral, say five or ten cwts., and to have an analysis made of such a mixed average sample.

2. Spanish Phosphorite (Estramadura Phosphate).

This mineral occurs in immense quantities at Lagrosa, near Tuxillo, in Estramadura. It is here associated with foliated apatite and quartz, and forms solid beds that alternate with limestone and quartz. This Spanish phosphorite has a fibrous structure, a light yellow colour, and a considerable degree of hardness. Reduced to powder, and placed upon a heated piece

of sheet-iron, it becomes beautifully phosphorescent—hence its name.

In Estramadura this phosphorite has been employed as a building-stone. Professor Hausmann, of Göttingen, in his classical Handbook of Mineralogy, published in 1847, says with respect to the Spanish phosphorite, that building purposes are probably the only use to which this mineral can be applied.

We in England of course know how to turn phosphorite to a better purpose than that of building houses with it. The fact, however, that such a valuable mineral is, or, more correctly speaking, has been, used for building purposes not many years ago, shows plainly in what immense layers it is to be found at Lagrosa. It is to be regretted that the want of adequate means of transport and other difficulties have hitherto prevented this valuable deposit from being brought in large quantities to the English market.

Several large cargoes of Estramadura phosphate, it is true, found their way hither two years ago, but the importers lost money by the speculation, although the mineral was sold at a rate quite high enough in comparison with the then current price of bone-ash and other phosphates.

The following analyses were made from average samples, fairly representing the composition of the different cargoes :—

Composition of Spanish (Estramadura) Phosphorite.

	No. 1.	No. 2.
Moisture and water of combination	·68	1·42
Lime	42·68	41·47
*Phosphoric acid	36·36	33·55
Oxide of iron, alumina, magnesia, and fluorine {determined by difference}	8·81	5·19
Insoluble siliceous matter	11·47	18·37
	100·00	100·00
* Equal to tribasic phosphate of lime (bone-earth)	78·79	72·69

It will be seen that the Spanish phosphorite is not equal to the best samples of Norwegian apatite. It is, however, a valuable mineral, since it is rich in phosphate and free from carbonate of lime.

Like Norwegian apatite, the Estramadura phosphorite must be reduced by means of powerful machinery to a fine powder, and afterwards treated with sulphuric acid, before it can be economically employed for manuring purposes.

Fibrous phosphorite has also been found at Amberg, in Bavaria. This phosphorite resembles, in composition and structure, that of Estramadura, but is distinguished from it by containing some iodine.

Bavarian phosphorite has lately been raised in some quantities,

and is used in Germany for the making of superphosphate, but as yet it has not found its way into England.

Another species of phosphorite, distinguished by the name of *osteolith*, was discovered some years ago near Hanau, in Germany. It occurs in thin seams in a volcanic rock, is soft and almost white, and very rich in phosphate of lime. Unfortunately the seams of this osteolith are not of sufficient thickness to repay the cost of excavation, consequently no practical application has been made of it as yet.

3. Cambridgeshire Coprolites.

The phosphatic nodules of the lower chalk are known in commerce under the name of Cambridgeshire coprolites. Their physical character and the localities where they are found are so well known that I need not dwell on these points.

The composition of different average samples, obtained by reducing to powder several tons, varies to some extent. In some more carbonate of lime and insoluble siliceous matter occur than in others, and consequently the amount of phosphate of lime in different samples fluctuates to a certain degree.

In commercial analyses it is usual to determine the amount of phosphate of lime or bone-earth by digesting the finely-powdered coprolites in hydrochloric acid, filtering off the solution from the insoluble siliceous matter, and precipitating the phosphates with ammonia. However careful the analyst may be to employ ammonia perfectly free from carbonic acid, and to avoid contact with the air, some carbonate of lime invariably falls down with the precipitated phosphates. It is necessary, therefore, to redissolve the latter in hydrochloric acid, and to throw them down a second time with ammonia. If this be neglected, the amount of phosphates in coprolites, and in all other phosphatic substances containing carbonate of lime, is determined too high.

By way of example, the following commercial analyses of powdered Cambridgeshire coprolites are given :—

General Composition of Cambridgeshire Coprolites.

	No. 1.	No. 2.	No. 3.	No. 4.	No. 5.	No. 6.
Moisture and a little organic matter ..	3·11	4·02	3·49	4·45	4·01	3·44
Phosphates	62·32	61·04	59·67	61·06	61·40	61·96
Carbonate of lime, magnesia, alkalies, and fluorine (determined by difference)	28·42	27·67	30·65	28·37	28·37	29·36
Insoluble siliceous matter	6·15	7·27	6·19	6·12	6·22	5·24
	100·00	100·00	100·00	100·00	100·00	100·00

" As both chalk-coprolites and Suffolk-coprolites contain much fluoride of calcium, by determining the amount of phosphates in the usual way by precipitation, fluoride of calcium is thrown down with the precipitate, in consequence of which the amount of phosphate of lime (bone-earth) is stated three to four per cent. higher than it is in reality. The true amount can only be correctly estimated by determining the percentage of phosphoric acid which they contain, and calculating from this acid the amount of bone-earth. In order to ascertain the true proportion of bone-earth in coprolites, and at the same time the exact quantity of other constituents which take up the sulphuric acid with which coprolite powder is mixed in the manufacture of superphosphate, I have made several detailed analyses of average samples of Cambridgeshire coprolites, and obtained the following results :—

Detailed Composition of Average Samples of Cambridgeshire Coprolites.

	No. 1.	No. 2.	No. 3.
Moisture and organic matter	4·63	4·01	3·52
Lime	43·21	45·39	46·60
Magnesia	1·12	·48	1·06
Oxide of iron	2·46	1·87	2·08
Alumina	1·36	2·57	1·41
*Phosphoric acid	25·29	26·75	27·01
†Carbonic acid	6·66	5·13	5·49
Sulphuric acid	·76	1·06	not determined
Chloride of sodium	·09	traces	traces
Potash	·32	·84	not determined
Soda	·50	·73	
Insoluble siliceous matter	8·64	6·22	6·04
Fluorine and loss	4·96	4·95	6·79
	100·00	100·00	100·00
* Equal to tribasic phosphate of lime (bone-earth)	54·89	57·12	58·52
† Equal to carbonate of lime	15·13	11·66	12·47
Amount of phosphates, determined in the usual way by precipitation	..	61·40	60·81

It will be seen that in the second sample the amount of phosphates obtained by precipitation is, in round numbers, four per cent. higher, and in the third sample two per cent. higher, than that resulting from the more accurate method of determining the percentage of phosphoric acid, and calculating from it the amount of bone-earth.

Powerful machinery is required for reducing coprolites to a fine powder. Coarse coprolite powder is not easily acted upon by acid, and has little or no effect upon vegetation. It is therefore advisable to reduce coprolites to a minute state of subdivision, and to digest them afterwards with a quantity of acid sufficient to saturate all the carbonate of lime and other con-

stituents, and to render the insoluble phosphates completely soluble.

This precaution is not always observed by manufacturers, and hence superphosphate made from coprolites is often of an inferior quality. Properly dissolved, they are converted into a most efficacious turnip-manure, for soluble phosphate of lime made from coprolites is in every respect as good as soluble phosphate made from bone or any other source.

4. Suffolk Coprolites (Pseudo or False Coprolites).

These phosphoric deposits occur in the more recent tertiary strata, as a layer varying from three to eighteen inches in thickness, between the coralline crag and London clay. The Suffolk crag is exceedingly rich in fossils, consisting partly of the fractured and rolled bones of cetaceous and other animals, with some fish-teeth, and chiefly of rolled water-worn pebbles, which were formerly supposed to be the fossilized excrements of saurian and other animals, for which reason they were called coprolites.

Professor Buckland, however, showed that they are not true fossil excrements, but in all probability calcareous pebbles which have undergone a peculiar metamorphosis, and become impregnated with phosphoric acid by long-continued contact with decaying animal and vegetable substances.

The name pseudo or false coprolites, which Professor Buckland proposed for them, has been generally accepted by the scientific world. In commercial phraseology, we have to understand by Suffolk-coprolites, or crag-coprolites, or pseudo-coprolites, the mixed fossil bones, fish-teeth, and phosphatic pebbles which occur in the Suffolk crag.

These phosphatic matters are distinguished from the grey-coloured chalk-coprolites by a brownish, ferruginous colour, and a smoother appearance. They are very hard, and yield on grinding a yellowish-red powder.

Analysed in the manner usually adopted in commercial analyses, the composition of several samples of ground Suffolk coprolites may be illustrated by the following tabulated results :—

General Composition of Suffolk Coprolites.

	No. 1.	No. 2.	No. 3.	No. 4.	No. 5.
Moisture and a little organic matter	4·61	3·80	4·11	6·28	4·74
Phosphates	56·52	60·21	61·15	60·99	44·20
Carbonate of lime, magnesia, fluorine, &c. (determined by difference)	25·95	21·77	22·39	21·74	20·92
Insoluble siliceous matter ..	12·92	14·22	12·35	10·99	30·14
	100·00	100·00	100·00	100·00	100·00

In good samples of Suffolk coprolites the amount of insoluble siliceous matter varies from 10 to 14 per cent.; No. 5, therefore, appears to be a very inferior specimen.

Besides fluoride of calcium, they contain a good deal of oxide of iron and alumina, which partially, at least, are thrown down with the phosphates when the latter are determined by precipitation with ammonia, as is usual in commercial analyses. In this case the amount of phosphates will be stated in excess. The true value of these pseudo-coprolites, therefore, can only be correctly estimated if the phosphoric acid which they contain is accurately determined. This has been done in the subjoined analyses, which at the same time represent their detailed composition.

Detailed Composition of Suffolk Coprolites.

	No. 1.	No. 2.
Moisture and water of combination with a trace of organic matter	5·76	2·53
Lime	40·70	38·20
Magnesia	·34	1·34
*Phosphoric acid	28·32	24·24
Oxide of iron	4·87	4·81
Alumina	..	3·72
†Carbonic acid	5·08	5·37
Sulphuric acid	·87	1·40
Potash	·78	·56
Soda	·25	1·18
Chlorine	traces	·07
Fluorine and loss	3·02	4·31
Insoluble siliceous matter	10·01	12·27
	100·00	100·00
* Equal to tribasic phosphate of lime (bone-earth)	61·30	52·52
† Equal to carbonate of lime	11·64	12·20

No. 1, it will be seen, is a very superior sample; No. 2 represents a good average sample of Suffolk coprolites. In two other samples, in which the amount of insoluble matter and phosphoric acid alone was determined, I find:—

	No. 1.	No. 2.
Insoluble siliceous matter	12·56	11·05
Phosphoric acid	23·48	24·26
Corresponding to bone-earth	50·87	52·56

The remarks already made respecting the conversion of chalk coprolites into superphosphate apply, with equal force, to the pseudo-coprolites of the Suffolk crag.

A new process for converting phosphatic nodules into effective manures has quite recently been communicated by a Frenchman—a M. Roblique—in the 'Comptes Rendus.' This gentleman recommends us to mix pulverised phosphatic nodules with

50 per cent. of their weight of sea-salt, and to expose this mixture to a current of steam placed in a furnace or cylinder at a temperature a little below red heat.

If, as is sometimes the case, the nodules do not contain a sufficiency of silica, the deficiency must be made up previous to the operation.

M. Roblique remarks: "The reaction of silica on chloride of sodium (salt) in contact with the vapour of water is well known, resulting in the formation of silicate of soda and hydrochloric acid. In this special case the latter acts on the phosphate of lime, from which it takes two equivalents of lime, and gives rise to chloride of calcium and biphosphate of lime. All the phosphoric acid does not, however, combine with the lime; it sometimes forms a considerable quantity of phosphate of soda. The same process thus furnishes in the dry state, without excess of acid, both silicates and phosphates, which readily yield to plants not only silica and phosphoric acid, but also a considerable quantity of alkali."

I have not been able to learn if this plan has been tried on a large scale and been found practicable. If, by any cheap method not necessitating the use of sulphuric acid, coprolites could be brought into a state in which the phosphates they contain can be readily taken up by plants, a great saving would be effected. I question, however, very much whether this new plan can be successfully carried out on a large scale, but think it well worth a trial.

5. Maracaibo or Monk's Island Guano (American Phosphate).

This singular phosphatic mineral was originally introduced into commerce under the name of Maracaibo Guano. It is also known as Columbian Guano, also as Monk's Island Guano, and is sometimes simply described as American Phosphate.

It occurs in large lumps, in which are frequently pieces of quartz-rock imbedded. These lumps are hard, and have a compact interior of a chocolate-brown colour, and a grayish-white mammillated exterior, resembling an enamel. Between this enamel-looking portion and the compact interior is a lighter brown porous structure.

It is reduced under a millstone with some difficulty into a brownish-gray powder. Burned in an open platinum capsule, it turns beautifully white, showing that it contains organic matter, which imparts a chocolate-brown colour to the lumps in their natural state.

A fair average sample, prepared by reducing to powder por-

tions taken from several blocks, was submitted to a careful analysis, which furnished the following results:—

Moisture	2·39
*Organic matter and water of combination	7·93
Lime	39·48
Magnesia	1·17
Phosphoric acid	41·34
Sulphuric acid	4·57
Soluble silica and sand	2·28
	99·16

* Containing nitrogen	·139
Equal to ammonia	·169

By dissolving this mineral in hydrochloric acid and precipitating the solution, filtered from the sand, with ammonia, 76·71 per cent. of phosphate of lime and magnesia (bone-earth) were obtained. The filtrate from the phosphate contained no lime whatever, but no less than 4·90 per cent. of phosphoric acid.

It is thus clear that Monk's Island Guano contains a phosphate which has a different constitution from that of ordinary tribasic or bone-phosphate of lime. On uniting the sulphuric acid with lime we obtain 7·77 per cent. of sulphate of lime, and, deducting the lime in the sulphate from the total quantity of lime found in the analysis, 36·28 per cent. of lime are left, which are united with phosphoric acid. The magnesia takes up 2·11 of phosphoric acid, and yields 3·28 of phosphate of magnesia (2 Ma, O, PO_5). There thus remains 39·23 of phosphoric acid to unite with 36·28 of lime.

From these data it appears that this singular and highly valuable phosphate consists chiefly of a mixture of pyro-phosphate and ordinary tribasic phosphate of lime. Since this substance contains a phosphate richer in phosphoric acid than ordinary or bone phosphate, and is free from carbonate of lime, it is rendered soluble with much less sulphuric acid than is required for dissolving bone-ash, apatite, and other phosphates. Monk's Island Guano, therefore, is a peculiarly valuable and excellent material for preparing artificial manures that are rich in soluble phosphate of lime.

6. Sombrero Rock, or Crust Guano.

This valuable phosphatic material occurs in one of the West Indian Islands, and of late years has been imported into England in some quantities. Sombrero Rock, as the name implies, is quarried in the islet of Sombrero. A large portion of this islet has been quarried away already, and sold both in America and in England as Crust or Sombrero Guano. This is not a very

appropriate name, for this material is not a guano deposit, but in reality the rock itself, of which the islet of Sombrero consists almost entirely. Although fragments of bones are not often found imbedded in the rock which is imported into England, it cannot be doubted that the latter is a true bone-breccia. I have in my collection a specimen of Sombrero Rock, in which several pieces of bone are distinctly visible. These pieces of bone are perfectly white, and free from organic matter. The rock varies considerably in colour, texture, and other external characters. Whilst some is porous and friable, other specimens are of considerable density. Most samples have a light yellowish-green colour, which is, however, sometimes varied by a bright green or bright yellow, a violet, bluish, or pinkish hue. On the whole, this rock is reduced to powder with tolerable ease.

I have carefully and minutely examined some average samples taken from a bulk of several tons, which gave the following results :—

Composition of Sombrero Rock or Crust Guano.

<table>
<tr><th></th><th>No. 1.</th><th>No. 2.</th><th>No. 3.</th><th>No. 4.</th><th>No. 5.</th><th>No. 6.</th><th>No. 7.</th></tr>
<tr><td>Moisture .. .. ..</td><td>9·06</td><td>7·51</td><td>10·09</td><td>4·22</td><td>2·94</td><td rowspan="2">15·10</td><td rowspan="2">13·08</td></tr>
<tr><td>Water of combination and a little organic matter .. .. ..</td><td>4·38</td><td>6·19</td><td>4·90</td><td>6·57</td><td>5·94</td></tr>
<tr><td>*Phosphoric acid ..</td><td>34·41</td><td>35·09</td><td>34·11</td><td>34·76</td><td>35·52</td><td>32·51</td><td>34·34</td></tr>
<tr><td>Lime .. ..</td><td>36·17</td><td>38·19</td><td>38·42</td><td>39·07</td><td>37·99</td><td>35·95</td><td>37·52</td></tr>
<tr><td>Magnesia .. .. ..</td><td>·36</td><td>·44</td><td>·41</td><td>·52</td><td>·58</td><td rowspan="2">2·74</td><td rowspan="4">11·73</td></tr>
<tr><td>Alkalies and fluorine</td><td>1·86</td><td>1·87</td><td>1·61</td><td>1·85</td><td>1·92</td></tr>
<tr><td>Oxide of iron .. ..</td><td>2·82</td><td>3·22</td><td>2·85</td><td>2·98</td><td>3·70</td><td rowspan="2">11·42</td></tr>
<tr><td>Alumina .. .. ..</td><td>6·89</td><td>4·26</td><td>4·23</td><td>6·23</td><td>7·55</td></tr>
<tr><td>Carbonic acid .. ..</td><td>1·55</td><td>1·36</td><td>1·68</td><td>1·75</td><td>·96</td><td>1·14</td><td>1·45</td></tr>
<tr><td>Sulphuric acid .. ..</td><td>·66</td><td>·44</td><td>·36</td><td>·36</td><td>·42</td><td>..</td><td>..</td></tr>
<tr><td>Chlorine .. .. ..</td><td>Not determined.</td><td>·39</td><td>·31</td><td>·28</td><td>·43</td><td>..</td><td>..</td></tr>
<tr><td>Insoluble siliceous matter .. .. ..</td><td>1·84</td><td>1·04</td><td>1·03</td><td>1·41</td><td>2·05</td><td>1·14</td><td>1·88</td></tr>
<tr><td></td><td>100·00</td><td>100·00</td><td>100·00</td><td>100·00</td><td>100·00</td><td>100·00</td><td>100·00</td></tr>
<tr><td>* Equal to tribasic phosphate of lime (bone-earth) .. .. ..</td><td>74·55</td><td>76·02</td><td>73·90</td><td>75·31</td><td>76·90</td><td>69·42</td><td>74·40</td></tr>
</table>

Sombrero Rock has been used in America for agricultural purposes, it is said, with considerable success, when simply reduced to powder. Such a practice cannot, however, be recommended; for this, like most mineral phosphates, requires to be treated with sulphuric acid in order to become really efficacious as a manure. It will be noticed that there is not much carbonate of lime, but a good deal of alumina, and in some samples also a good deal of oxide of iron. The proportion of phosphate of lime

in this rock is as high as in good samples of South American bone-ash.

Phosphatic rocks similar in composition to the Sombrero Rock have lately been discovered in the Anguilla Isles, forming part of the Leeward Islands.*

7. Kooria Mooria Guano.

A considerable portion of the Kooria Mooria guano imported into England is bought up by manure manufacturers, and by means of sulphuric acid converted into useful turnip-manures.

Although this guano may be used by itself as a manure for turnips or Swedes, it is better to add to it some sulphuric acid (say one-third of its weight), with a view to changing a portion of the insoluble phosphates, in which it is rich, into the more efficacious form of a soluble phosphate.

Kooria Mooria guano varies considerably in composition, as the following analysis made in my laboratory will show :—

Composition of Kooria Mooria Guano.

	No. 1.	No. 2.	No. 3.	No. 4.	No. 5.	No. 6.	No. 7.
Moisture	9·63	5·94	4·12	9·53	5·43	6·21	7·84
*Organic matter	5·68	8·49	3·49	5·19	11·45	5·01	3·23
Phosphates of lime and magnesia (bone-earth)	53·93	46·39	55·21	56·09	35·04	61·20	60·03
Sulphate of lime ..	4·37	11·73	14·79	2·82	13·88	8·39	2·68
Alkaline salts and magnesia (chiefly common salt) ..	6·48	5·12	1·97	6·09	5·33	5·68	8·68
Insoluble siliceous matter (sand) ..	19·91	22·33	20·42	20·28	28·87	13·51	17·54
	100·00	100·00	100·00	100·00	100·00	100·00	100·00
* Containing nitrogen	·33	·30	·21	·26	·33	·28	·26
Equal to ammonia	·40	·36	·25	·31	·40	·34	·31

Kooria Mooria guano, it will be seen, contains but little organic matter, and hardly any ammonia. It is generally met with in commerce in a tolerably fine powder, offering its phosphates in that finely divided state which enables plants to assimilate them more readily than those found in coprolites or other like substances which have become completely fossilized.

8. Other Phosphatic Guanos.

There are several species of African and West Indian guanos which at present are occasionally used in the manufacture of

* *Vide* Communication by Sir Roderick Murchison, in Journal, vol. xx. p. 31.

artificial manures. They are generally distinguished from the Peruvian by the almost entire absence of ammonia and soluble phosphates, by the small quantity of organic matter, and by the large proportion of insoluble phosphates which they contain. On the latter the commercial value of these guanos chiefly depends. They usually contain a considerable quantity of gypsum, and occasionally carbonate of lime besides. If a guano is to be used as a manure without any further preparation, the presence of carbonate of lime, though it does not add to, does not detract from its value; but if the guano is to be employed as the basis for superphosphate, or for drying artificial manures containing soluble phosphate, the less carbonate of lime it contains the better.

If guano containing carbonate of lime is mixed with sulphuric acid, all the carbonate must be saturated with acid before any soluble phosphate can be formed; and again, if such a guano be added as a drying material to a manure containing soluble phosphate, the carbonate of lime of the guano, taking up the acid which keeps the phosphate in a soluble state, renders the latter insoluble. In either case more acid is required for the production of a given amount of soluble phosphate than is wanted if phosphatic materials free from carbonate of lime are employed.

Saldanha Bay guano, South African, Pedro Keys, Swan Island, Baker Island, Birds' Island guanos are some of the inferior phosphatic guanos which may be used either by themselves, or better after having been treated with some sulphuric acid. As the composition of nearly every cargo of these guanos varies greatly, the analysis of particular samples is of no general interest. I therefore pass them over as well as the analyses of some other kinds of phosphatic guanos which occasionally find their way into the market.

9. Bone-Ash.

Bone-ash of good quality unquestionably is one of the most valuable materials for making superphosphate of lime. Indeed, it is far too good to be used for agricultural purposes in any other form. Most of the bone-ash of commerce comes from South America, and possesses, like other commercial articles, a variable composition, arising chiefly from the mechanical impurities, such as sand and earth, with which it is always more or less contaminated.

The following commercial analyses of different samples of South American bone-ash will give an idea of the extent of this variation :—

Composition of South American Bone-ash.
(Commercial Analysis.)

No.	Moisture.	Organic Matter.	Moisture and Organic Matter.	Phosphates of Lime and Magnesia (Bone-earth).	Carbonate of Lime, Fluoride of Calcium, and Alkaline Salts.	Insoluble Siliceous Matter (Sand).	Total.
1	7·60	2·29	..	67·58	9·36	13·17	100
2	2·05	3·52	..	74·08	12·59	7·76	100
3	10·76	3·76	..	55·36	7·45	22·67	100
4	14·50	2·56	..	65·89	9·44	7·61	100
5	12·52	1·20	..	66·33	7·17	12·78	100
6	..	..	16·37	64·44	9·13	10·06	100
7	..	..	14·38	67·99	10·45	7·18	100
8	..	..	7·75	68·97	7·62	15·66	100
9	..	..	10·49	60·63	9·99	18·89	100
10	..	..	9·04	66·71	7·34	16·91	100
11	..	..	10·53	66·33	7·25	15·89	100
12	..	..	8·76	75·76	8·57	6·91	100
13	..	..	13·98	66·59	8·42	11·01	100
14	..	..	8·08	61·61	9·40	20·91	100
15	..	..	7·73	72·65	9·45	10·17	100
16	..	..	9·68	64·70	7·63	17·99	100
17	..	..	6·87	75·05	12·02	6·06	100
18	..	..	8·07	65·26	12·26	14·41	100
19	..	..	12·97	63·17	11·62	12·24	100
20	..	..	9·59	70·45	10·72	9·24	100
21	..	..	14·58	67·74	8·66	9·02	100
22	..	..	11·91	73·48	10·43	4·18	100
23	..	..	3·29	82·48	10·33	3·90	100
24	..	..	5·63	77·15	10·36	6·86	100
25	..	..	9·61	64·27	9·95	16·17	100
26	..	..	17·31	59·67	8·29	14·73	100
27	..	..	5·44	75·81	10·47	8·28	100
28	..	..	8·26	70·50	10·32	10·92	100
29	..	..	14·45	59·13	8·89	17·53	100
30	..	..	8·60	69·09	7·13	15·18	100

The above were made in the manner usually adopted for commercial analyses. It will be seen that, generally speaking, samples poor in phosphate of lime are also poor in carbonate of lime, lime not united with phosphoric acid, and alkaline salts; and the samples rich in phosphate of lime likewise contain a higher percentage of the latter constituents. Thus, the sample which contained 66·33 of bone-earth, yielded 7·13 of carbonate of lime, &c.; and the sample containing 64·70 of bone-earth, yielded 7·63 of carbonate of lime, &c.; whilst that which gave 70·45 of bone-earth yielded 10·72 of the latter constituents; and another sample in which 75·05 per cent. of bone-earth were found yielded 12·02 of carbonate of lime, &c.

Considerable allowance of course must be made for the natural variations in the composition of the bones which produced the ash. It is well known that some bones contain more carbonate

of lime and likewise more alkaline salts than others. We must not, therefore, expect to find always in the richest samples the highest percentage of carbonate of lime, &c., nor in those poor in bone-earth necessarily a correspondingly low percentage of the last-mentioned constituents. But, generally speaking, a higher percentage of carbonate of lime and alkaline salts will be found in good samples of bone-ash than in those that are inferior. This we may naturally expect, for as pure bones contain a certain amount of carbonate of lime, &c., the less sand a sample of bone-ash contains, and the more perfectly the bones are burned, the more phosphate of lime and likewise the more of all the other incombustible constituents it necessarily must contain. On the other hand, if bones are imperfectly burned and contaminated with much sand, they naturally must yield an ash which is not only poorer in phosphates but in all the ash-constituents of bones. At all events, bone-ash must contain more bone-earth and more carbonate of lime and other mineral matters than the bones which furnished the ashes.

In commercial analyses, however, the proportions of carbonate of lime, &c., are frequently stated to be far smaller than can be the case. This mistake arises from the faulty determination of the bone-earth. When determined in the usual way, the precipitated bone-earth invariably contains a good deal of carbonate of lime. The phosphates are therefore given higher than they are in reality, and, as it is usual to determine the rest of the lime which is not united with phosphoric acid and the alkaline salts together by difference, the latter constituents are consequently stated too low.

Thus an analysis lately brought under my notice gives the composition of a sample of bone-ash as follows:—

Charcoal	2·1
Sand	4·3
Water	3·8
Carbonate of lime	1·9
Phosphate of lime	87·9
	100·0

Another chemist, who analysed the same bone-ash, gives the following results:—

Moisture	3·00
Carbonaceous matter	3·00
Siliceous matter	3·90
Phosphate of lime	84·84
Carbonate of lime (4·48) &c.	5·26
	100·00

In both analyses the amount of phosphate of lime is given too high, and that of carbonate of lime and alkaline salts too low.

The first analysis, more especially, has evidently been done in a very careless manner, for bone-ash prepared from pure bones does not contain so high a percentage of phosphate of lime as this sample of the commercial article is reported to contain. The proportion of charcoal, moisture, and sand—three matters not properly belonging to pure bone-ash, amount to 10 per cent. in round numbers. Deducting these accidental constituents, and calculating the results for pure bone-ash, the latter would contain no less than 97·66 per cent. of bone-earth. It is hardly conceivable how such absurd results as those contained in the first analysis can be committed to paper by an analytical chemist.

If these were solitary instances I would take no further notice of analyses the incorrectness of which is proved by abundant internal evidence. But unfortunately this is not the case. Bone-ash is usually sold by importers at a price depending upon the percentage of phosphate of lime in it, and hence it is not the interest of dealers to have the determination of bone-earth made by a chemist who states the amount correctly, but rather to employ an analyst who, adopting an expeditious and incorrect method, makes the percentage of phosphates 3, 4, and even 6 per cent. higher than it is in reality. The importance of this subject has led me to examine minutely the composition of pure and of commercial bone-ash.

The mineral portion of pure bones or pure bone-ash has been repeatedly examined by various chemists. The more recent researches by Professor Heintz, of Berlin, deserve especial notice. According to Heintz, the phosphate of lime present in bone-ash is a combination of 3 equivalents of lime and 1 equivalent of phosphoric acid; its formula consequently is $3\,C\,O + P\,O_5$. Although some chemists still retain the older formula $8\,C\,O + 3\,P\,O_5$ assigned to bone-earth by Berzelius, most agree with Heintz in considering the chief constituent of bone-ash to be the tribasic phosphate of lime. In the analyses of human and other bones, the same gentleman obtained a certain proportion of lime, which was neither united with phosphoric acid, as tribasic phosphate, nor with carbonic acid. This excess of lime is calculated in Heintz's analyses as fluoride of calcium. Thus he states in one place that human bones contain 3·52 per cent. of fluoride of calcium; in another analysis he gives 3·82 per cent. of fluoride of calcium in bones dried at 212° Fahr. It should be mentioned, however, that no direct fluorine determination has been attempted, but that the result has been obtained by calculation. Every chemist is acquainted with the fact that bones contain small quantities of fluorine; but, at the same time, considerable difficulty is experienced occasionally in obtaining with recent bones a deep etching upon glass, even if large

quantities of bone or of bone-ash are employed in testing for fluorine. It strikes me that such an etching would be readily produced if bones really did contain from 3·52 to 3·85 per cent. of fluoride of calcium, as calculated by Heintz. Moreover, such a proportion of fluoride of calcium would admit of at least an approximate determination. I have endeavoured to determine quantitatively the proportion of fluorine in recent bones and in bone-ash; but although I have carefully tried all known methods for determining small quantities of fluorine, I have utterly failed in all attempts, and am inclined to think that the proportion of fluoride of calcium in recent bones is very much smaller than Heintz imagines it to be. To verify this supposition, I added 1 per cent. of finely-powdered fluoride of calcium to pure phosphate of lime, and then was able to ascertain the amount of fluorine with tolerable precision. This is not the place to mention the details of my experiments, but the conclusion to which they seem to lead is that recent bones contain only a small amount of fluoride of calcium, and not 3½ per cent. in round numbers as stated by Heintz. This much is certain, that the mineral portion of bones contains a certain quantity of lime, which is neither united with carbonic acid, nor with phosphoric acid as tribasic phosphate.

If it be highly improbable that this excess of lime exists in bone-ash entirely in the state of fluoride of calcium, the question naturally arises, In what combination does it occur? As lime and phosphoric acid unite together in so many different proportions, and as many of these compounds are basic in their character, it is highly probable that bone-ash contains a more basic phosphate of lime than has hitherto been supposed to exist.

It is a matter of considerable practical importance that the composition of the precipitate which is obtained on adding caustic ammonia to a dilute solution of bone-ash in hydrochloric acid should be known with certainty. This precipitate, consisting of phosphate of lime and a little phosphate of magnesia, is usually called bone-earth. It was considered by Berzelius to be a combination of 8 equivalents of lime and 3 equivalents of phosphoric acid; its formula accordingly is $8\,C\,O + 3\,P\,O_5$.

Other chemists assign to it the formula $3\,C\,O + P\,O_5$. Indeed, most scientific chemists of the present day have, for good reasons, given up the older formula, and consider bone-earth to be principally tribasic phosphate of lime,—that is a combination of 3 equivalents of lime and 1 equivalent of phosphoric acid.

In commercial analyses the amount of bone-earth is usually determined by precipitation; but since some chemists very properly prefer to ascertain the total amount of phosphoric acid in the article submitted to analysis, and to calculate subsequently

the phosphoric acid as tribasic phosphate of lime, the ammonia precipitate, which is still erroneously assumed by many to be $8\,CO + 3\,PO_5$, is recalculated as tribasic phosphate of lime. This practice deserves to be strongly condemned, for it leads to wrong results, giving invariably the amount of tribasic phosphate much higher than it is in reality. Great discrepancies in the determinations of phosphate of lime in bone-ash, &c., by different analysts, are a source of constant annoyance and frequent disputes between seller and buyer. As long as the practice prevails of ascertaining the phosphates simply by precipitation, such discrepancies must remain matters of almost daily occurrence.

It is, of course, a much more expeditious plan to determine the phosphates by precipitation than to ascertain correctly the amount of phosphoric acid; but if we consider the difference that an error of 3 or 4 per cent. of phosphate of lime will make in the value of a ship's cargo, we shall admit that accuracy ought not to be sacrificed to expedition. There is, indeed, ground to fear that analyses are carried out in a too commercial—nay, often a too interested—spirit, such as is calculated to bring analytical chemistry into disrepute. It is therefore the duty of all desirous of carrying out analytical investigations in a manner consistent with truth to raise a strong opposition against the mode in which more especially commercial analyses of bone-ash and animal charcoal are frequently executed at present.

I have myself repeatedly analysed the ammonia precipitate from bone-ash, and arrived at the conclusion that, under the most favourable circumstances, it never contains less than 3 equivalents of lime for 1 equivalent of phosphoric acid. Generally, however, it contains an additional quantity of lime, or, more correctly speaking, carbonate of lime,—for I find it extremely difficult to prevent more or less carbonate of lime from falling down with the phosphates when precipitating the latter with ammonia. This is especially the case when the precipitation is effected in a hot solution. Notwithstanding the entire absence of carbonic acid in the ammonia used for precipitation, and the observance of every precaution to exclude the air from the precipitated phosphates, some additional lime beyond the proportion required to combine with phosphoric acid to form tribasic phosphates is invariably found in the precipitate obtained from a boiling-hot solution, even after the precipitate has been re-dissolved and thrown down again a second or third time. If, on the contrary, the precipitation is effected in the cold, and the phosphates are re-dissolved in acid after washing with ammonia-water, and thrown down again a second time with pure ammonia from a dilute cold solution, I find their composition agrees closely with tribasic phosphate of lime. Thus from a sample of bone-

ash, which yielded an amount of phosphoric acid corresponding to 82·59 of tribasic phosphate of lime, I obtained 82·48 per cent. of phosphate by precipitation.

But unless these precautions are carefully observed and the phosphates are washed with strong ammonia-water, discordant results are obtained. At the best, the method of determining the amount of phosphate of lime by precipitation is liable to furnish results that cannot be relied upon. In proof of these statements the following instances may be cited :—

Two separate determinations in bone-ash gave 75·84 per cent. and 73·29 per cent. of bone-earth by the ordinary method of precipitation.

In another sample, I obtained, by throwing down the phosphates once, 79·03 per cent.

By re-dissolving the phosphates in acid and precipitating a second time, 76·21 per cent. were obtained.

On analysing the 79·03 per cent., I obtained 34·95 per cent. of phosphoric acid, corresponding to 75·72 of tribasic phosphate; whilst the precipitated phosphates in the second determination (76·21 per cent.) furnished 34·89 per cent. of phosphoric acid, corresponding to 75·59 per cent. of tribasic phosphate.

A sample of animal charcoal gave—

Phosphates precipitated once	77·46
Re-dissolved and precipitated a second time	73·63
Again re-dissolved and thrown down a third time ..	72·96

A direct determination of phosphoric acid in the same sample of animal charcoal furnished 33·34 per cent., which, calculated as tribasic phosphate of lime, gives 72·23.

These results thus show that the amount of bone-earth is stated too high if the phosphates are thrown down only once; that a tolerably near approach to truth is obtained if the phosphates are re-dissolved in acid and thrown down a second time; and, that lastly, perfectly accordant results are obtained if the phosphoric acid is determined, and from it the amount of tribasic phosphate is calculated.

Since bone-ash, animal charcoal, coprolites, &c., are chiefly purchased for the sake of the phosphoric acid which they contain, all possible care should be bestowed to obtain an accurate determination of that constituent which mainly regulates their commercial value.

In purchases of bone-ash, the dealer generally guarantees a certain amount of phosphate of lime or bone-earth; but since a question may arise as to the precise meaning of these terms, I would suggest, as far more satifactory both to the purchaser and the honest dealer, that the seller should guarantee the percentage of phosphoric acid; or, to render the change in present

usages less abrupt, phosphoric acid, equal to say 74 or to 76 per cent. of tribasic phosphate of lime, as the case may be. If this suggestion were generally adopted, all squabbles respecting the composition of bone-earth would be set aside. By stating the amount of phosphoric acid which was actually found in the analysis, and the corresponding percentage of tribasic phosphate of lime, it would be seen at once that a reliable method, and not the uncertain process of precipitation, had been employed by the analyst.

The correct determination of phosphoric acid is attended with a good deal of trouble, and necessitates much care and experience on the part of the operator.

The method of analysing bone-ash which I have adopted in my laboratory yields most satisfactory results ; and, as it may be useful to others, I will give a brief outline of it.

Moisture and organic matter are determined as usual. About twenty grains of finely-powdered bone-ash are carefully dissolved in hydrochloric, or better in nitric, acid ; the solution is evaporated to dryness in a waterbath. By this means any pyrophosphate which may be present in the bone-ash is converted into the ordinary phosphate, and the soluble silica which always occurs in commercial bone-ash is rendered insoluble. The dry residue is taken up in the smallest possible quantity of nitric acid, and the sand filtered off; the solution passing through the filter is heated to the boiling-point, and precipitated with an excess of oxalate of potash or ammonia. The oxalate of lime held in solution by the liberated oxalic acid is thrown down with the first precipitate of oxalate of lime by neutralising the liquid with caustic potash or soda, by adding afterwards an excess of oxalate of potash or soda, and boiling. The oxalate of lime is removed by filtration, and the filtrate and washings evaporated to a small bulk, and finally the phosphoric acid precipitated with ammoniacal sulphate of magnesia. To prevent any oxide of iron or alumina, which occasionally are present in commercial bone-ash, from falling down with the phosphate of magnesia, it is desirable to add a little tartaric acid to the liquid before precipitating the phosphoric acid.

The precipitated phosphate of magnesia has to be set aside for at least twelve hours before it may be safely collected on a filter. As an excess of oxalate of potash has to be used for the determination of lime, and an excess of ammoniacal sulphate of magnesia for the determination of the phosphoric acid, oxalate of magnesia is formed, which, after standing for a time, separates and falls down with the phosphate of magnesia, unless a very large amount of ammoniacal salts is present. I find, indeed, that the phosphate of magnesia obtained in this kind of

analysis is almost always contaminated with oxalate of magnesia, and therefore make it a general practice to redissolve the partially-washed precipitated phosphate of magnesia in ammonia, and to throw it down a second time. The magnesia precipitate must be washed with strong ammonia water.

The lime precipitate generally continues a variable and often altogether insignificant proportion of phosphate of iron and alumina. In ordinary analyses, it is hardly necessary to take any notice of the traces of phosphate of iron, which exist in good white samples of bone-ash. For very minute analyses, I dissolve the lime precipitate, after having been weighed, in hydrochloric acid, precipitate the solution with ammonia, collect precipitate on a small filter, wash and redissolve on filter, and precipitate a second time in the cold. The phosphate of iron and alumina, after washing, is free from lime. Its weight is determined, and deducted from the first weight of the lime precipitate. In order to obtain the phosphoric acid contained in the phosphate of iron and alumina, the precipitate is dissolved in hydrochloric acid, a little tartaric acid is added, then ammonia, and finally the phosphoric acid is determined as phosphate of magnesia. If necessary, a separate determination of carbonic acid and sulphuric acid is made in the bone-ash.

As regards accuracy, this plan of analysis leaves nothing to be desired. A proof of this is furnished in the subjoined analyses of the same sample of bone-ash; two of them were made by myself, and two by my first assistant, Mr. Sibson.

Though all ordinary care is taken in preparing a sample for analysis, it is next to impossible to obtain a perfectly homogeneous powder. The trifling discrepancies in the results of the four separate analyses are due, perhaps, in a higher degree to this circumstance than to the method of analysis.

Composition of a Sample of Bone-ash.

	1st Analysis.	2nd Analysis.	3rd Analysis.	4th Analysis.
Moisture	6·34	6·34	6·35	6·35
Organic matter (chiefly charcoal)	3·38	2·83	3·26	2·84
*Phosphoric acid	34·95	34·48	34·89	34·83
Lime	44·35	43·93	43·59	43·99
Magnesia	1·12	1·19	·71	·97
Insoluble siliceous matter (sand)	8·43	9·34	9·39	8·83
Carbonic acid and alkalies (determined by loss)	1·43	1·89	1·81	2·19
	100·00	100·00	100·00	100·00
* The phosphoric is equal to tribasic phosphate of lime (bone-earth)	75·72	74·71	75·59	75·46
Average percentage of bone-earth	..	..	75·32	..

The same bone-ash was likewise submitted by myself and by Mr. Sibson to an analysis, in which the ordinary precipitation method was adopted, and the following results were obtained:—

	Voelcker.	Sibson.
Water	6·34	6·35
Organic matter	3·38	3·09
Phosphates	79·03	76·70
Carbonate of lime	3·18	5·34
Alkaline salts	2·68	2·52
Insoluble siliceous matter	8·43	9·39
	103·04	103·39

In explanation of these results, I may observe that the excess in the analyses is principally due to the circumstance that all the lime which is not united with phosphoric acid is introduced here as carbonate of lime. The alkaline salts likewise help to increase the excess, for in reality the greater part of the alkalies occurs in bones as such, or in union with phosphoric acid, the total amount of which is mentioned in the analyses already. The direct weight of the thoroughly-heated residue, which is obtained on evaporation of the liquid from which the phosphates and the lime have been removed, therefore gives the alkalies too high.

In reality commercial bone-ash contains seldom more than $1\frac{3}{4}$ to 2 per cent. of carbonate of lime, and the lime which is not in union with phosphoric acid, nor with carbonic acid, must therefore be present in some other state of combination. Some of it, no doubt, is present as fluoride of calcium and some as silicate of lime; silicate of lime is not a normal constituent of bone, but it is produced when bones are reduced to ash in large heaps. The silica, which is usually attached to raw bones in the shape of fine sand, at a high temperature, decomposes some of the carbonate of lime which bones naturally contain, and gives rise to silicate of lime.

It might, perhaps, be supposed that bone-ash contained some caustic lime, arising from the high temperature at which the bones are sometimes burned. But this is not generally the case, as I have proved repeatedly by determining the amount of carbonic acid in the natural sample, as well as after having moistened and heated it with carbonate of ammonia. Had there been any caustic lime present in the bone-ash, the portion treated with carbonate of ammonia would have yielded a larger amount of carbonic acid than the sample analysed in its natural state, whereas both furnished almost identical results.

Again, commercial bone-ash contains a little sulphate of lime, but its quantity is quite insignificant.

In all the following analyses, phosphoric acid and lime have

been carefully ascertained; in several the magnesia, sand, carbonic acid, and the small amount of sulphuric acid and oxide of iron and alumina which generally occur in bone-ash, have been determined:—

Detailed Analysis of South American Bone-ash.

	No. 1.	No. 2.	No. 3.	No. 4.	No. 5.
Moisture	4·83	9·91	15·34	3·29	10·30
Organic matter	4·06	1·75	2·03		
*Phosphoric acid	35·38	33·89	32·52	38·12	29·56
*Lime	41·27	39·53	37·84	44·47	34·48
Lime not united with phosphoric acid	3·53	4·07	1·92	4·45	1·02
Insoluble siliceous matter (sand)	6·95	8·32	6·51	3·90	20·24
Magnesia	·97	·99	1·48		
Carbonic acid	..	·78	·84	..	·77
Sulphuric acid	..	..	·37		
Oxide of iron and alumina ..	..	..	·21	5·67	3·63
Alkalies	..	1·39	·84 (By difference)		
Alkalies, carbonic acid, and loss	3·01	..	..	..	..
	100·00	100·63	100·00	100·00	100·00
*Forming together bone-earth (tribasic phosphate of lime)	76·65	73·42	70·46	82·59	64·04

For analyses required for practical purposes, it is, indeed, unnecessary and often impossible to determine accurately all the constituents besides the phosphoric acid; but whether two or half-a-dozen constituents are determined, the analytical results should be correct, and be stated in such a manner that manufacturers and agriculturists who prefer making their own superphosphate, can make use of an analysis as the basis for calculating the amount of acid which will be required for rendering the bone-ash soluble. The method most commonly used for determining the phosphates, as well as the present mode of stating the results, are equally objectionable. I would, therefore, recommend for adoption the method and the mode of stating the results adopted in analysis No. 4. In this, it will be seen, phosphoric acid, lime, and sand are the only constituents that have been determined separately; moisture and organic matter are ascertained together, and all the rest by difference.

Pure Bone-ash.

I have asserted that the amount of phosphate of lime found in commercial bone-ash is frequently overstated, and that the

constitution of pure bones is well known, and affords a ready means for checking such errors. It has appeared to me more desirable to prove this assertion by the results of direct investigations of my own than to base it upon calculations derived from published analyses of bones.

With this view I prepared samples of ox and horse bones, selecting the cleanest and hardest. The bones, after being carefully scraped, were broken into small pieces, which were soaked in cold distilled water for a week, in order to remove any soluble salts. After that time they were reduced to powder; this was repeatedly washed with distilled water. The bones thus purified were next burned in a platinum capsule at a moderate heat, the ash was again washed repeatedly with distilled water, then moistened with carbonate of ammonia in order to convert any caustic lime which might have been produced during burning into carbonate. Direct experiments, however, showed that the heat employed was not sufficiently strong to drive off carbonic acid.

Although both the bones and their ash were washed with a great deal of water, it was found impossible completely to remove the alkalies. Even the hardest bones contain some potash and soda. By long washing, the amount of alkalies may be diminished, but hitherto I have not been able to obtain a bone-ash perfectly free from alkalies, though I have washed small quantities for longer than a fortnight on a filter.

Prepared in this way, the ash of horse and ox bones, in a perfectly dry state, was found to consist of:—

Composition of the Ash of—

	Horse-bones.	Ox-bones.
*Phosphoric acid	40·29	39·81
Lime	55·01	55·43
Magnesia	·84	·80
Potash	·25	·49
Soda	·03	·60
Carbonic acid	2·99	3·52
Sulphuric acid	traces	·04
Chlorine	traces	·06
	99·41	100·75
* Corresponding to tribasic phosphate of lime (bone-earth)	87·29	86·25

The ash of the ox-bones was not washed quite so long with water as that of the horse-bones, and contains for this reason rather more potash and soda. These results are here stated as they have been actually obtained in the analysis. In bone-ash,

the phosphoric acid is united with magnesia and with lime, and the carbonic with lime. The traces of chlorine and sulphuric acid, in all probability, are present as sulphate of soda and chloride of sodium.

By uniting together the analytical results in the same manner in which the constituents occur in bone-ash, we obtain for the ash of—

	Horse-bones.		Ox-bones.	
Tribasic phosphate of lime, $3 CaO + PO_5$. Consisting of—				
Phosphoric acid	38·77		38·38	
Lime	45·24		44·77	
		84·01		83·15
Phosphate of Magnesia. $2 MgO, PO_5$. Consisting of—				
Magnesia	·84		·80	
Phosphoric acid	1·51		1·43	
		2·35		2·23
		86·36		85·38
Carbonate of Lime. Consisting of—				
Lime	3·80		4·48	
Carbonic acid	2·99		3·52	
		6·79		8·00
Lime, neither united with phosphoric acid nor with carbonic acid	..	5·97	..	6·18
Potash	..	·25	..	·49
Soda	..	·03	..	·51
Chloride of sodium	..	traces	..	·11
Sulphate of soda	..	traces	..	·07
	..	99·40	..	100·74

In perfectly pure bone-ash thus we find no more than $85\frac{1}{2}$ to $86\frac{1}{2}$ per cent. of phosphate of lime and magnesia (bone-earth). It will be noticed that pure bone-ash is much richer in carbonate of lime than the commercial articles, after deduction of sand and other accidental impurities. There is no silica in pure bone-ash, and it is the silica in the shape of fine sand which, driving out carbonic acid from the carbonate of lime, causes the difference in the proportion of carbonate of lime found in pure and the commercial bone-ash respectively.

After uniting the lime and magnesia with phosphoric acid, and the carbonic acid with lime, it will be seen a considerable quantity of lime remains over. I do not think it probable that all this lime is present in the shape of fluoride of calcium.

The state of combination in which it may exist, is of com-

paratively speaking little importance to the manufacturer of artificial manures. But the fact pointed out in my analyses, I believe for the first time, that there is in bone-ash, and of course also in bones themselves and in bone-black, a considerable excess of lime over and above the lime in the phosphate and the carbonate, will explain why a larger proportion of oil of vitriol must be used for producing a certain amount of soluble phosphate from bone-ash than appears to be necessary according to prevailing theory.

The theory of the formation of soluble phosphate from insoluble bone-earth has been perfectly well known some years; it is not affected by apparent discrepancies between so-called theoretical calculations and actual practice. In the case before us the simple fact is, that in all the analyses of bone-materials a considerable quantity of lime has been overlooked or been supposed to be united with phosphoric acid. As this excess of lime, which I have pointed out as existing in all bone-materials, takes up sulphuric acid when such material is employed for making soluble phosphate, more acid is required than has hitherto been supposed. It is a common complaint of manufacturers of superphosphate, that the materials which they use do not produce the quantity of soluble phosphate which they ought to yield. There is, however, nothing surprising in this complaint, for it originates in a proceeding that rests on calculations in which altogether erroneous data are employed. Instead of 77 per cent. of phosphate of lime, as supposed, the bone-ash employed in all probability only contains 73 per cent.; and instead of 2 or 3 per cent. of carbonate of lime, there is an additional quantity of lime, equal to 5 to 8 per cent. of carbonate of lime, to be saturated before any soluble phosphate can be produced.

10. Animal Charcoal (Bone-Black).

The animal charcoal or bone-black which is used by sugar-boilers for decolourizing crude sugar is far too valuable a material to be used for agricultural purposes. When it has served for some considerable time as a decolourizing agent it loses its effect, and then is revivified by heating in cylinders. This revivifying process is repeated many times, until most of the carbon in the black is burned off; it is then sold to manure-manufacturers as a refuse material, under the name of animal charcoal. Like all refuse materials, its composition varies greatly. Some samples are very rich in phosphates, others poor. The amount of sand is usually very small; in some samples I have found a large proportion of carbonate of lime.

The subjoined analyses illustrate the differences found in samples of various qualities:—

Composition of Animal Charcoal (Bone-black).

	No. 1.	No. 2.	No. 3.	No. 4.	No. 5.	No. 6.	No. 7.
Moisture and organic matter	30·26	9·52	30·15	27·98	17·38	12·63	12·54
Phosphates of lime and magnesia	60·75	82·48	55·01	49·69	68·53	68·41	70·16
Carbonate of lime, magnesia, &c. (by difference)	5·96	6·19	8·81	13·90	9·42	14·27	12·77
Insoluble siliceous matter	3·03	1·81	6·03	8·43	4·67	4·69	4·53
	100·00	100·00	100·00	100·00	100·00	100·00	100·00

11. Bones.

Bones are used for agricultural purposes in the following states:—

a. Bone-dust.
b. Boiled Bones.
c. Bone Shavings.

a. Bone-Dust.

Before crushing, raw or butchers' bones are now generally boiled out in an open cauldron, and by this means deprived, in a great measure, of their fat. As an article of commerce fat is the most valuable constituent of bones. As a manuring agent it has no value whatever, or perhaps, more strictly speaking, its presence is undesirable, inasmuch as it retards the decomposition and solution of the bones. Far from being injurious, the removal of fat from the bones decidedly improves their agricultural value.

The following is the average composition of a number of samples of bone-dust analysed by me:—

Moisture	12·06
*Organic matter	29·12
Phosphates of lime and magnesia (bone-earth) ..	49·54
Carbonate of lime (determined by difference) ..	6·99
Alkaline salts and magnesia (chiefly common salt)	1·91
Sand	·38
	100·00

* Containing nitrogen	3·69
Equal to ammonia	4·49

In the next table is given the composition of—

No. 1. Sound foreign bones.
„ 2. Decayed foreign bones.
„ 3. Decayed and sound foreign bones mixed.
„ 4. London bones.

	No. 1.	No. 2.	No. 3.	No. 4.
Moisture	12·02	12·15	12·13	12·31
*Organic matter	28·71	27·27	27·80	30·73
Phosphate of lime and magnesia (bone-earth)	49·28	52·99	52·70	49·72
Carbonate of lime (determined by difference)	4·37	4·35	4·17	4·25
Alkaline salts	4·55	2·59	2·84	2·78
Sand	1·07	·65	·36	·21
	100·00	100·00	100·00	100·00
* Containing nitrogen	3·44	3·31	3·43	3·73
Equal to ammonia	4·17	4·02	4·16	4·52

In decayed bones the proportion of organic matter is not quite so great as in sound bones, and the phosphates are rather higher. But the differences are not sufficiently striking to require any comment. In the preceding analyses, the lime which is left in solution after the phosphates have been removed has likewise been determined quantitatively. Calculated as carbonate of lime, it amounts in the four analyses to 8·60, 8·71, 7·50, 7·78, respectively.

b. Boiled Bones.

The bones from which glue-makers have extracted a certain portion of gelatine and nearly all the fat are known in commerce under the name of boiled bones. It must not be supposed, however, that boiled bones do not contain any organic matter, nor furnish on decomposition any ammonia. The following two analyses show the contrary :—

Composition of Two Samples of Boiled Bones.

Moisture	8·06	7·70
*Organic matters	25·45	25·27
Phosphates of lime and magnesia (bone-earth)	60·48	43·73
Carbonate of lime	3·25	9·77
Alkaline salts	·43	
Sand	2·33	13·53
	100·00	100·00
* Containing nitrogen	1·84	2·78
Equal to ammonia	2·24	3·37

c. Bone Shavings.

Bone-shavings are produced in button-works, manufactories of knife-handles, &c., &c. Being the turnings of hard bones they contain rather more phosphate of lime and a little less organic matter or nitrogen than ordinary bone-dust.

Composition of Bone Shavings.

Moisture	13·12
*Organic matter	26·12
Phosphates of lime and magnesia	53·74
Carbonate of lime	5·39
Alkaline salts	·78
Sand	·85
	100·00
* Containing nitrogen	3·28
Equal to ammonia	3·98

Purchasers of this valuable refuse should be on their guard, for it is frequently mixed with vegetable ivory—a substance which has no appreciable value as a manure, and which resembles so closely bone shavings that the admixture cannot be recognised by simple inspection.

XIX.—*Statistics of Live Stock and Dead Meat for Consumption in the Metropolis.* By Robert Herbert.

Notwithstanding that the arrivals of stock from abroad have continued on an extensive scale, and that most of our markets have been fairly supplied with English beasts during the past six months, the beef trade has ruled somewhat active, and prices have been higher than in the previous five years. Although last season was by no means favourable for fattening live stock, owing to the enormous quantities of rain which fell in most parts of England, most kinds of beasts disposed of in Smithfield were decidedly superior in weight and condition to those exhibited in 1859. This is an important step in the right direction, though we admit that even a further improvement will have no important influence upon prices. When, however, we find this improvement extending itself to the Devons, Herefords, &c., as well as the Short-horns, we seem to have before us the promise of steadier prices than have prevailed during many previous seasons. The greatest improvement as regards weight and quality of meat has been effected in the various crosses, but more especially those derived from the North of Scotland, where it would appear that cross-breeding has been, on the whole, more

successfully carried out than in England. Amongst the stock shown in London, we have observed a much smaller number of young animals than usual: hence it would appear that the grazing community have of late conducted their operations upon, in our opinion, a comparatively safe principle; and, unless we are greatly mistaken, that principle will eventually be found more profitable to themselves, and certainly more conducive to the interests of the consumers generally, than a *too rapid* forcing.

The inferior and musty state in which the bulk of the hay-crop was secured last year is an unfavourable feature, whilst the want of adequate warmth fully to ripen the beet-crops is likely to be severely felt during the next two or three months. With all these drawbacks, however, there is at present no cause for assuming that any kind of meat will be much higher in price than it now is, or that our markets are likely to be very scantily supplied with either beasts or sheep; though, of course, consumption will fall almost wholly upon home-fed stock until after the re-opening of the navigation on the continent, from whence we are advised that very large numbers of sheep—chiefly crosses with English breeds—will be shipped in the spring in admirable condition. The numbers of beasts, too, in process of fattening for the London market are represented as unusually large. The Dutch graziers, by crossing, have succeeded in producing sheep of great weight and very full of fat, both internally and externally. If such marked success has attended the crossing of sheep, how is it that some efforts are not made to improve the beasts by a similar process? Again, no attempt has as yet been made to improve the quality or weight of those wretchedly poor importations from Germany *viâ* Hamburg. Surely mutton must be very low in price on some parts of the continent, when whole sheep can be disposed of in our markets at from 18*s.* to 23*s.* each, and yet leave, after paying freight, commission, &c., some profit to the shippers!

With respect to the production and consumption of mutton during the past six months, we may observe that the former has not kept pace with the demand, which has continued remarkably healthy. Prices have further advanced, and the best old Downs have reached the high figure of 6*s.* per 8 lbs. This advance must, in a great measure, be attributed to the prevalence of rot even amongst some of our best breeds, and which, of course, has operated against the butchers. The rotten sheep have been disposed of at low rates, since they have carried very little internal fat; a supply of this kind has tended to give considerable support to the tallow market, and to run up the value of rough fat to 3*s.* 2½*d.* per 8 lbs. This high price for fat is likely to continue in spite of the high range in the value of money, since we find

that nearly the whole of the tallow in London—over 70,000 casks—is held by wealthy importers. Irrespective of the price of tallow and fat, however, one thing is evident, that the continued increase in the commercial operations of the country—internal as well as external—must tend to support the value of the better kinds of food, even though the supplies may eventually increase. We have now to direct attention to the following table, showing the supplies of stock disposed of in the great metropolitan market in the periods indicated :—

Supplies of each kind of Stock Exhibited and Sold during the last Six Months of the following Years :—

	1855.	1856.	1857.	1858.	1859.	1860.
Beasts	133,577	129,509	137,915	147,118	143,198	145,420
Cows	3,185	2,864	2,918	3,137	3,030	3,015
Sheep and Lambs	791,798	689,444	701,414	747,829	803,334	762,740
Calves	14,810	14,480	15,006	15,186	12,277	15,766
Pigs	22,350	18,733	14,992	19,441	16,130	15,470

From the above comparison it will be seen that the supplies of beasts in the last six months of 1860 were somewhat on the increase, but that those of sheep exhibited a decrease, compared with the corresponding period in 1859, of 40,594 head. Taking the supplies as a whole, we have reason to be satisfied at the exertions made by our graziers and breeders in providing, under somewhat adverse influences, for the wants of the great community.

The quarters from whence the metropolis derived its supplies of beasts, in the last six months of the year, are thus shown :—

"District" Bullock Supplies.

	1855.	1856.	1857.	1858.	1859.	1860.
Northern Districts ..	52,800	60,760	81,600	66,260	64,470	66,140
Eastern Districts	9,800	..	7,000	6,970	3,600	9,500
Other parts of England	11,050	20,700	15,370	13,820	23,220	20,500
Scotland	2,993	2,734	1,836	2,674	4,640	1,151
Ireland	9,800	11,000	12,000	13,760	10,544	7,852
Foreign	35,418	33,381	25,984	30,797	30,394	37,573

This important statement shows that the Northern districts have forwarded fair, perhaps full average, supplies of beasts. From the Eastern counties the number was unusually large; but, from other parts of England, only moderate. The most remarkable falling off is in the arrival of beasts from Scotland.

We understand that in most parts of that country stock has been selling at a much higher rate than in England, and has consequently been chiefly disposed of at home. It will be seen, too, that the arrivals from Ireland show a deficiency of 2692 head when compared with 1859, and of 5908 when compared with 1858. The imports of foreign stock, however, show an increase in the last half-year of over 7000 head. This is an important addition to our home supplies, which have still been seasonably large. The value of beef and mutton, per 8 lbs. by the carcase, ruled as follows in each year:—

Average Prices of Beef and Mutton.

	1855.		1856.		1857.		1858.		1859.		1860.	
BEEF:—	*s.*	*d.*	*s.*	*d.*	*s.*	*d.*	*s.*	*d.*	*s.*	*d.*	*s.*	*d.*
Inferior	3	4	3	0	2	10	2	10	2	10	2	8
Middling	4	2	4	0	3	10	4	0	4	0	4	0
Prime	5	2	5	2	4	10	5	2	5	2	5	4
MUTTON:—												
Inferior	3	4	3	4	3	0	2	10	3	0	3	2
Middling	4	0	4	2	4	2	4	0	4	2	4	6
Prime	5	0	5	4	5	4	5	2	5	2	5	10

This statement is a somewhat remarkable one. In the first place, it shows a falling off in the value of inferior beasts and sheep compared with the average of the five previous half-years, but a rise in the prices of really prime animals. For instance, the average of beef was 5*s.* 4*d.* in 1860, against 5*s.* previously; middling mutton advanced about 6*d.* and prime qualities 8*d.* per 8 lbs. The decline in the value of inferior stock must be solely attributed to great competition on the part of the foreign graziers. This must be obvious when we state that over 168,000 foreign sheep were imported into London in the last six months of 1860.

Both Newgate and Leadenhall markets have been extensively supplied with each kind of meat; nevertheless the demand has continued somewhat active, at very full prices. Scotland, we may observe, forwarded smaller quantities of beef and mutton than usual; but our midland counties furnished more than average supplies.

5, *Argyle-square, St. Pancras, London.*

XX.—*On a Course of Cropping adopted in Kent.* By R. Heathorn.

The object of the present communication is to show the modifications of the four-course system, which have been introduced and carried out both on heavy and light soils, on the farm of E. L. Bells, Esq., of which Mr. Freeman is manager. Without attempting to detail the numerous trials and experiments resorted to before the present system was established, I may state that profit was throughout kept steadily in view, and an increase of green crops the best means that suggested itself to that end.

The farm on which this system has been carried out consists of 800 acres, divided by the river Medway into two parts, of which the portion on the western side of the river is light land, that on the east heavy land. After ten years' experience, the cleanliness of the land and fruitful appearance of the crops bear witness to the efficacy of the course adopted.

I must, however, premise that cleanliness in farming is essential under this system. Our plan has been, as soon as the crop is removed, to have the stubble (or gratten) carefully looked over, and the couch, crowsfoot, &c., spudded and brought off by hand and burnt. The broadshare is then set to work (for which purpose I have found no implement as effectual as Coleman's scarifier), and, finally, the stubble is cleared and the crops sown.

We have been enabled to adopt this system of autumn cultivation by introducing the use of one-horse carts in harvest-time, and by stacking the corn in the field where it was grown. I thus find that we are enabled to carry the corn with about one-half of the strength which it originally took; and, without increase in the number of horses permanently kept, we can apply the services of nearly one-half to the purpose of early cultivation. In spring, likewise, the hand and horse hoe must be kept in constant action, so that the weeds may be kept down until the standard crop has assumed an ascendancy which cannot afterwards be disturbed.

I will now detail first the management of light land, following the cultivation of one field, of from 30 to 40 acres, through an eight-years' course.

1st year.—A barley-stubble, or gratten, of the required dimensions is carefully looked over and weeded by hand, and then cultivated as before stated; after which one-fourth of the land is ploughed and sown with rye, one-fourth is harrowed and sown with trifolium, one-fourth is ploughed and sown with tares, the remainder is subjected to a winter-fallow for mangold. This

provides for a succession of spring-feed; for, when the rye has been fed off, the trifolium comes into its prime, and tares follow when the trifolium is consumed. When the rye and trifolium are disposed of, the ground is dunged and ploughed for swedes; these are drilled with a compost of ashes and dried nightsoil (the nightsoil is collected and dried for this purpose in a bay filled with ashes). To these 2 cwt. of superphosphate to the acre are added; the time of drilling being about June 20th; and I have observed year after year, and more particularly in the years 1857 and 1858, that these late-sown swedes escaped mildew, whilst those earlier sown were severely affected. The swedes that were sown in 1858, after the foregoing crops, were not "firsted" (set out with the hoe) until August 6th, and yet they proved one of the finest pieces in the district. One-third of this crop is carted home for the beasts in the yard, the remainder being fed off with fatting sheep. When the tares are fed off, the land is treated in the same manner as for swedes, and sown with white turnips to be eaten off by fatting sheep.

The land under preparation for mangold, after its winter-fallow, is dunged and ploughed and treated like that for swedes, with the addition of 4 cwt. per acre of guano at the time of sowing. This crop is all drawn and clamped for the use of the beasts in the yard and the breeding ewes.

Let me here call attention to the great quantity of food for stock which has been raised in this course, and yet the manure applied to the root-crops, and left behind by the high-fed fatting sheep, will have imparted more elements of enrichment to the soil than have been withdrawn by the growing crops.

In the 2nd year, barley is sown with clover.

3rd year.—The clover is mown twice, and dunged for wheat.

4th year.—Wheat, followed by turnips.

To enable us with advantage to get this succession crop, the horse and hand hoe must have been actively brought into use whilst the corn was young, and the land must be in good heart. The land will then present a very different appearance when the corn is cut, from that which it would have assumed if it had been dealt with in a niggardly manner, and the cultivation required will be proportionately less. A single ploughing will then suffice to prepare the land for turnips.

After trying many descriptions of turnips, I have come to the conclusion that the only sorts adapted for the wheat gratten are the Orange-jelly and White-stone turnip, on account of the quickness with which these two kinds come to maturity. The firsting and seconding of this crop, together with the working of the horse-hoe, keep down the weeds. These turnips are in general

fed off with ewes and fat lambs in the spring, and on an average produce three-fourths of an ordinary fallow-crop.

5th year.—Oats. One-half of this crop is sown with trefoil; the other half is broadshared and cleaned immediately on the removal of the corn.

6th year.—One-half trefoil. This crop we invariably cut for hay; it produces an average of from 2 to 2½ tons per acre. As soon as the hay is removed, the land is broadshared and dunged for turnips to be consumed by fatting sheep. The other half of the oat gratten is dunged for winter or mazagan beans, or else for peas. If beans are sown, the land is carefully hand and horse hoed, and then sown with turnips between the drills. If the crop is peas, I prefer that rape should follow; for I find that wheat does better after peas, if rape is interposed, than if mustard or turnips are tried.

7th year.—Wheat. An objection may be raised that the feeding of turnips or rape must delay the wheat-sowing till a late period. On land, however, of this description, I consider that we are in good time if we have finished wheat-sowing by the second week in December.

Such has been the course of cropping, and the land, if inspected, will show for itself that it has not been impaired, but vastly benefited by the system adopted. The advantages gained are manifest: for first, by this management the land, light and heavy together, is enabled to fatten from 700 to 800 tegs; to keep 300 breeding-ewes, and to fat them and their lambs; to fat yearly from 40 to 50 beasts, besides keeping many head of lean stock in the yards, chiefly on roots; and of all this stock I calculate that one-third is kept and fattened by the succession crops.

2ndly. The fallow is entirely done away with. The varied cultivation of the land so keeps the surface moving that the weeds *cannot* grow if they would; the nourishment which would have gone to maintain rubbish being taken up by the standard crop.

3rdly. We see that in the course of eight years fatting sheep are fed no less than six times on the land, and I need hardly enlarge upon the benefit which the soil will receive from the extra corn and cake which they consume.

4thly. These green crops are so good a preparation for cereals that we now grow more corn than under the old system.

On the heavy land the rotation is as follows:—

1. Rye and tares. The land is manured and ploughed. I prefer manuring for this crop rather than the succeeding ones—

swedes or mangold. A part of this crop should be mown for the horses, &c.; the rest consumed by fatting sheep.

After tares, swedes or white turnips are drilled as on the light land. One-third of this crop is carted home, and the rest fed off on the land.

After rye follows mangold. The ground is ploughed deep, and the mangold drilled. As a sure, safe, and cheap crop, the mangold stands pre-eminent: for breeding-ewes in spring it is invaluable.

2. Oats. The foregoing crops tend to lighten and fertilize the soil, so that we look for a good crop of oats. Here the horse and hand hoe ought to be kept in constant action, and when the crop is carted the cultivation of the gratten must be vigorously carried out.

3. Beans. Manured with dung, drilled in rows about 18 inches apart. They should be kept clean, and, as soon as convenient, turnips should be sown between the drills. Turnips fed off with fat sheep.

4. Wheat.

5. Barley.

6. The clover mown twice, and then dunged for wheat.

7. Wheat.

8. Oats. As soon as convenient after broadsharing the wheat gratten, I plough it on the heave.

I have thus stated the system which I have found most conducive to profit for my own soil and climate. I am too well aware of the great variety to be found in the qualities of soils (some being tenacious in the extreme, whilst others are of a comparatively pliable nature) to believe that these methods admit of universal application. With poor farming it cannot be applied with advantage to any soil, but *that* objection is very little to the purpose.

I may observe, however, that on the chalky soils of Kent the four-course rotation is still profitably maintained; and, in my opinion, very few and slight deviations could there be beneficially introduced. A crop of oats after wheat, aided by a top-dressing of artificial manure, may, however, even here occasionally answer its purpose well.

Preston Hall Farm, Aylesford.

XXI.—*On the Composition of the Yellow Lupine, and a Soil suitable to its Culture.* By Dr. Augustus Voelcker.

The yellow lupine (*Lupinus luteus*), a well-known ornamental plant of our flower-gardens, is now extensively cultivated as a field-crop in several parts of Germany, France, and Belgium; more especially it is largely seen in the sandy districts of Northern Germany and Prussia, where it is considered a very important crop to the farmer, inasmuch as it will thrive luxuriantly on poor, blowing sands, upon which no other leguminous crop can be grown.

A short account of the manner in which this new field-crop is grown in Germany will be found in vol. xx. (1859) of this Journal. It appears from this account, given by Baron Herman von Nathusius, of Hundisburg, near Magdeburg, that two distinct species of lupine, the yellow and the blue, are grown in Prussia. The yellow lupine (*Lupinus luteus*), being more succulent and covered with more and larger leaves than the blue (*Lupinus angustifolius*, Linn.), is generally preferred to the latter, especially if grown as green food, and not for seed.

Lupines are grown in Germany principally for the sake of the seeds, which, like those of all leguminous plants, constitute a very nutritious food, and in their composition and nutritive qualities, as far as these have been ascertained, do not differ much from peas and lentils.

Occasionally the yellow lupine is grown as a green manure. It is considered very useful for that purpose.

More rarely lupines are grown in Germany for the sake of affording green food to sheep and cattle. For this latter purpose I think, however, the yellow lupine is well adapted. If I am not mistaken, the field-culture of lupines will, if at all practicable in this country, be found chiefly valuable as a source of green nutritious food for sheep and cattle, on soils upon which clover and the finer and more nutritious kinds of grasses either refuse to grow altogether, or only furnish a scanty supply of inferior green food.

The English agricultural community is indebted to Mr. Thomas Crisp, of Butley Abbey, for the publication of Baron Nathusius' account respecting the cultivation of lupines in Germany. This gentleman, as far as I know, was the first who, in 1858, successfully attempted their introduction as a field-crop in this country. Mr. Crisp speaks very highly of their importance to the farmer, and strongly commends their cultivation

to the notice of the occupiers of light sandy soils. This recommendation has not been made in vain; and I have now the pleasure of communicating the results of an experimental trial undertaken by my friend and former pupil, Mr. James Kimber, of Tubney Warren, Oxfordshire.

At my request, and in answer to many questions relating to the cultivation, and practical feeding value of lupines, the character of his land, &c., Mr. Kimber has kindly addressed to me a letter, which contains much valuable information on these and a few other topics interesting to the practical agriculturist.

I make no apology for appending to this paper Mr. Kimber's interesting communication, assured that it will be read with pleasure and profit by many who have to deal with poor, sandy land, on which clover will not grow even once in eight years, turnips either fail altogether or become affected by anbury and fingers-and-toes, and on which it is next to impossible to grow a fair average corn-crop.

The detailed account given by Mr. Kimber relieves me of the necessity of myself describing the experimental trial. But I may observe that the trial was intended to test the comparative merits of lupines as a green food and as a crop grown for the sake of its seed.

Unfortunately the dry weather at the time of sowing in the spring, and the subsequent cold and wet summer, so much retarded the blossoms that all hope of carrying out the experiments as originally intended had to be given up. The seeds of the lupine ripen very unequally, especially in wet seasons, when it is not unusual to see almost ripe seed-pods and yellow blossoms on the same plant. Though a quantity of ripe seed-pods were gathered, yet by far the larger portion of the plants did not ripen their seed this season, and therefore the experiment was necessarily confined to testing the feeding value of the green lupines, as well as this could be done in one season, by weighing the produce in green food, and ascertaining its chemical composition.

The lupine plants submitted to analysis were cut down on the 24th of September. They were nearly 4 feet high and full of yellow blossoms. The lower part of the central stem was hard and woody, so much so that sheep would not have eaten it. The tops were quite soft and succule[illegible] and there were plenty of leaves and tender side-shoots on th[illegible]ms.

It appeared to me desirable to ascertain by [illegible]ion of the plants which would probably be rejected by [illegible] that likely to be consumed by them.

I therefore detached the leaves and soft tops from the woody

stems, taking about 6 inches of tops, and thus separated the green plants into :—

	Parts.
Woody stems	29·5
Leaves and soft tops (6 inches)	70·5
	100·0

If anything, the proportion of woody stems is rather over than under estimated, for, as stated, only 6 inches of the top were cut off; I think it likely, therefore, that some of the woody stems would be eaten by sheep or cattle.

A water-determination of the green lupine plants gave 89·20 per cent., and an ash-determination, 80 per cent. of ash on an average.

The amount of nitrogen in the green plants was found to be ·38 per cent. Accordingly lupine plants, cut down green, consist, in 100 parts, of :—

	In Natural State.	Dried at 212° F.
Water	89·20	..
Dry matter :—		
*Organic	10·00	92·58
Inorganic	·80	7·42
	100·00	100·00
*Containing nitrogen	·38	3·51
Equal to albuminous compounds	2·38	22·03

In cabbages analysed last year I found the average proportion of water 89·5 per cent. There is thus about as much water in lupines, cut down green, as in the cabbages, the analysis of which I published some time ago; the amount of mineral matter is likewise nearly the same in both, but the proportion of albuminous or flesh-forming matter is more considerable than in cabbages.

The greater portion of the dry matter in lupines I found insoluble in water, as will be seen by the following results, representing the general composition and proportion of juice and crude fibre in the plants analysed in my laboratory :—

General Composition of Yellow Lupines (cut down in a green state).

		In Natural State.		Calculated Dry.
Water	..	89·20	..	..
Soluble organic matters ..	juice 93·10	3·29	juice 36·13	30·46
Soluble mineral matters ..	..	·61		5·67
Insoluble organic matters ..	..	6·71	..	62·12
Insoluble mineral matters ..	crude fibre 6·90	·19	crude fibre 63·87	1·75
		100·00		100·00

In the next table is stated the detailed composition of lupines, both in a natural state and dried at 212° Fahr. :—

Detailed Composition of Yellow Lupines (cut down in a green state).

	In Natural State.	Dried at 212° F.
Water	89·20	..
Oil	·37	3·42
*Soluble albuminous compounds	1·37	12·68
Soluble mineral (saline) substances	·61	5·64
†Insoluble albuminous compounds	1·01	9·35
Sugar, gum, bitter extractive matter, and digestible fibre	3·96	36·68
Indigestible woody fibre (cellulose)	3·29	30·48
Insoluble mineral matters	·19	1·75
	100·00	100·00
*Containing nitrogen	·22	2·03
†Containing nitrogen	·16	1·48

The juice of the green plants has a somewhat bitter taste, which is due to a bitter principle, the nature of which I have not further examined.

Sheep and cattle soon get accustomed to lupine, and even like it much after some time; but pigs, it appears, refuse this kind of food.

With respect to the nutritive qualities of green lupines, I would observe that the plants grown by Mr. Kimber are not nearly so nutritious as clover, lucerne, sainfoin, green rye, and rape, and indeed most other crops grown as green food. The large proportion of woody fibre and, comparatively speaking, the small amount of sugar in these lupines, certainly do not speak in their favour. On the other hand they contain quite as large an amount of albuminous or flesh-forming matters as the better kinds of crops grown as green food; but the amount of albuminous matters in food, as has been stated repeatedly in former contributions of mine, cannot be regarded as a trustworthy indication of the feeding or fattening qualities of any kind of green food.

Green food, described by practical men as good, sweet, nutritious herbage, like good roots, I find, invariably contains a considerable proportion of sugar. The deficiency of this constituent in lupines, coupled with the large amount of woody fibre and water, justifies me in considering lupines decidedly inferior to clover and other artificial grasses usually grown in this country as food for cattle and sheep.

Nevertheless, lupines cut down green under peculiar circumstances, when grown, for instance, on very poor sandy soils, on which more valuable crops will not thrive, will no doubt be found a useful auxiliary food.

These observations, it should be remembered, apply more especially to the specimens examined by me, and not generally to lupines grown under other and probably more favourable

circumstances. It is well known that the chemical and physical condition of the soil has a mighty influence on the nutritive qualities of the crops raised upon it. In like manner the kind and amount of manure applied to the land tend to modify the composition of the produce, and with it its nutritive properties. And, finally, it ought not to be forgotten that the past summer was unusually wet and cold, and consequently decidedly unfavourable to the proper ripening of the herbage and the abundant formation of sugar, whilst it contributed, no doubt, to an unusually large proportion of water in all green food.

We have yet to learn to what extent the composition of lupines is affected by our changeable climate, by the soil, time of cutting down, &c. &c., before a generally correct opinion can be expressed as regards their value as green food.

It is well to bear in mind especially that the amount of water in every description of vegetable produce varies immensely with the circumstances under which it is raised. Thus I find the percentage of water in swedes varying from 86 to 91 per cent.; in turnips, from 87 to 94 per cent.; in mangolds, from 85 to 90 per cent. A chemist analysing a particular swede and finding the amount of water in that root to be 91 per cent., and also analysing a turnip and finding only 88 per cent. of water in this turnip, and not knowing the fluctuation in the amount of water and dry matter to which both roots are liable, might thus incautiously derive from these analyses the conclusion that turnips are more nutritious than swedes. In the same manner a farmer who one year consumes unusually good turnips, and the next, poor swedes, containing it may be 91 per cent. of water, might arrive precisely at the same opinion as the analyst. But what is perfectly true in particular instances does not apply to the vast majority of cases; we must therefore beware of deducing general conclusions from isolated facts.

In green food more especially the amount of water, and also that of other constituents, varies considerably. Thus in the analyses of one and the same kind of clover, lucerne, and sainfoin, as recorded by Professor Way, Dr. Anderson, and myself, we meet with the following differences:—

	Percentage of Water in Fresh State.		Percentage of Flesh-forming Matters in Dry State.	
	Highest.	Lowest.	Highest.	Lowest.
Red Clover—Trifolium pratense	85·30 (Anderson.)	79·98 (Anderson.)	22·194 (Way.)	12·46 (Anderson.)
Cow-grass—Trifolium medium	81·76 (Anderson.)	74·10 (Way.)	20·968 (Way.)	10·19 (Anderson.)
White Clover—Trifolium repens ..	83·65 (Voelcker.)	79·71 (Way.)	27·31 (Voelcker.)	18·45 (Way.)
Lucerne—Medicago sativa	80·13 (Anderson.)	69·95 (Way.)	16·56 (Voelcker.)	12·56 (Way.)
Sainfoin—Onobrychis sativa	77·32 (Voelcker.)	76·64 (Way.)	18·17 (Way.)	15·50 (Voelcker.)

It is by rejecting unusual or abnormal results, and striking an average of numerous determinations of the same produce, that practically useful data are obtained. Proceeding in this way, the averages of different analyses often agree very closely. Thus the percentage of water in the various clovers on an average amounts to :—

According to Way	78·25
" Voelcker	78·65

In the absence of any other analysis of lupines cut down in a green state, besides that given above, the expressed opinion can only apply to the particular crop analysed, and our judgment respecting the average nutritive qualities of lupines in comparison with other food must remain suspended until the data are produced on the strength of which a trustworthy opinion can be formed.

On the Soil suitable to the Cultivation of Lupines.

It has been already remarked that lupines succeed well on light, sandy, and even poor, blowing sandy soils. The agricultural capabilities of the soil on which the yellow lupines were grown in the experiment under discussion are described in detail in Mr. Kimber's letter. I can therefore proceed at once to state its chemical composition.

The analysis was made from two samples, taken at the depth of 6 and 12 inches respectively, and then well mixed.

The first sample contained a percentage of—

Water	1·12
Organic matter	2·07

The second, which was darker coloured,—

Water	·81
Organic matter	·81

The mixture gave the following results when submitted to a minute analysis :—

Composition of a Sandy Soil on which Lupines were grown successfully by Mr. Kimber, Tubney Warren, near Abingdon, Oxon.

Moisture	·96
*Organic matter	1·46
Oxides of iron and alumina	1·84
Phosphoric acid	·17
Carbonate of lime	·23
Sulphate of lime	·04
Magnesia	·24
Potash	·12
Chloride of sodium	traces
Insoluble siliceous matter (chiefly fine quartz-sand)	95·01
	100·07
*Containing nitrogen	·075
Equal to ammonia	·091

It will be seen that this soil contained no less than 95 per cent. of insoluble siliceous matter, chiefly in the form of fine quartz-sand. The proportion of all the other constituents is, therefore, necessarily very small indeed. Thus we find in it hardly more than traces of potash, little phosphoric acid, and barely any lime—a constituent which is seldom so deficient in any soil.

As the field had received a dressing of farmyard manure previous to the sowing of the seed, some of the phosphoric acid, lime, and potash probably are due to the manure. Analysed in its natural condition, it is likely to exhibit in a still more striking manner this general deficiency of all the more important and valuable soil-constituents. Notwithstanding, it produced a luxuriant crop of lupines, weighing in a green state about 21 tons per acre.

The small proportion of sulphate and carbonate of lime in this soil is striking, and it is certainly remarkable that the crop, nevertheless, succeeded well. Leguminous crops, to which lupines belong, are, generally speaking, much improved by a dressing of gypsum or lime. I cannot help thinking, therefore, that a good dose of one of these substances may increase the produce and materially improve the feeding qualities of this crop. It may be partially due to the almost total absence of sulphuric acid and lime in this soil that the analysis of the lupines has not furnished more favourable results. My reason for throwing out this suggestion is based on the fact that every description of agricultural produce is increased by applying lime in some shape or other to land which is peculiarly deficient in this substance, and on the no less important observation of good farmers that turnips grown on land very poor in lime possess a low feeding value.

Whilst recommending the use of gypsum or *lime* as a means of increasing the produce and improving its quality on land like that on which the experimental lupines were grown, I would mention, however, that chalky and marly soils, according to the experience of trustworthy men, do not appear to be well adapted to this crop. It is likewise stated that land in too high condition does not suit it, and that on wet or imperfectly-drained land lupines do not succeed.

A deep, porous, naturally dry or perfectly-drained soil is essentially requisite for growing the crop to perfection, and as chalky and marly soils often rest on impervious clays or wet peat, it is probably due to these latter, and not to the excess of lime, that lupines fail in chalky or marly soils.

From the preceding observations, the following general conclusions may be drawn :—

1. Green lupines are a useful crop, which may be grown in England with much advantage on poor sandy soils, on which clover, sainfoin, and other kinds of produce do not succeed well.
2. Yellow lupines are useful as a green food for sheep and cattle.
3. The nutritive value of lupines cut down green, in comparison with clover, lucerne, sainfoin, rye, and other green food, remains to be determined by future and numerous analyses, and, above all, by an extended experience of practical men.
4. On soils destitute of lime and sulphuric acid, the application of gypsum, lime, marl, and road-scrapings (provided the road-metal consists of limestone) is likely to increase the produce and enhance the feeding value of the lupines.

Royal Agricultural College, Cirencester, December, 1860.

To Dr. Augustus Voelcker.

I HAVE great pleasure in answering your inquiries respecting my experiment with lupines as a farm crop. Let me give you in the first place some idea of the nature of the soil on which they were grown.

My farm is situated about 7 miles south-west of Oxford, and 2 miles south of the Thames; geologically, in the neighbourhood of the Coral Rag. Ours is mostly sandy land, interspersed with stone-brash.

The soil of this farm is what is commonly called a light, blowing sand, of so fine a nature that high winds very much disturb the surface in dry weather, and sometimes cause considerable injury to young growing plants—to turnips more especially. The sand-beds mostly rest on a porous sandstone rock, and therefore require no draining; on the contrary, we often suffer from drought: one week of hot, dry weather in the summer is enough to check the growth of corn. This season has not tested the powers of lupines to withstand dry, hot weather on poor, light sands; but, considering their habit of growth, it is likely that they possess this power in a great degree. They have a tap-root more than a foot in length. This sandy land possesses a very low agricultural value. Much of it has been brought into cultivation within the last few years; and at the present time there are still acres to be seen growing nothing but furze and heaths. The value of this kind of land varies from 10*s.* to 30*s.* an acre. My farm is made up principally of the lowest class. The field in which the lupines were grown may be considered of medium value. It has averaged 20 bushels of wheat and 28 bushels of barley to an acre when farmed in the four-course rota-

tion, which I do not consider well suited for so poor a soil, although it is often adopted here. A section of a stone-pit gives the following:—First 6 inches, rather dark cultivated soil; below this, 2 feet of a somewhat lighter soil; below this, 10 feet of yellow sand, resting on sandstone rock.

With regard to the crops generally grown here, I may say wheat and barley are the favourites. A fair crop of peas may be grown occasionally, but the land does not bear a repetition of this crop for a long time. Clovers may be grown once in eight or ten years. Sainfoin generally takes well, and yields good crops when top-dressed with road-scrapings and yard-manure. Carrots are well suited to the soil. Above all, turnips grow to perfection if the land is well prepared and well manured for them; superphosphate appears to be the most suitable manure. On these sands, after they have been in cultivation for some years, turnips grow well, and are not subject to the disease of anbury; but in some places, on newly cultivated land, they fail altogether. On land where turnips are attacked by anbury, the plants generally look healthy and well until the time of hoeing; the leaves then turn pale or yellow, and the roots seldom get bigger than a finger.

As you wish to know how the field was cultivated and cropped previous to the lupines being planted, I will give you an account of the last five years:—In 1856 it was in clover, unmanured. 1857, wheat, top-dressed with 1½ cwt. Peruvian guano per acre. In the autumn the stubble was pared and cleaned, and winter vetches drilled; these were top-dressed with 10 2-horse cart-loads of yard-manure to an acre. 1858, vetches, eaten on the land by sheep. After the sheep the land was cultivated with a broadshare, cleaned, ploughed with a shallow furrow, and turnips drilled with 3 cwt. superphosphate. The turnips having been eaten on the land by sheep having hay, the land was next ploughed as shallow as possible. 1859, the broadshare passed across the furrows, and barley drilled. 1860, 10 2-horse cart-loads of well-made pig-manure applied to the acre in the last week of March, and ploughed in with a furrow 4 inches deep; the lupines drilled on the 3rd of April in rows 13 inches apart; 1½ bushel of seed per acre.

Three weeks passed before the plants made their appearance aboveground, and then only a few came up. On the 1st of May they were so thin on the ground that I quite despaired of a crop; however, they continued to increase in numbers, and at the end of six weeks from the time of planting there were enough. I am informed by a seedsman that the yellow lupine is always a long time coming up; but I may mention that in this instance

the land was very dry at the time of planting, and the weather was very cold and dry for some time afterwards.

In the first six weeks after the plants appeared they made very little progress; at the end of that time their growth became astonishingly rapid; and by the first week of August they were just beginning to bloom, and the piece had a most luxuriant appearance. By the middle of August the lupines were so thickly covered with flowers as to appear almost a mass of yellow, and they continued in this state until the time of weighing, Sept. 24th.

I cannot give you much information on the feeding properties of green lupines. Having had a wish to save as many as I could for seed, with a view of testing the feeding properties of the dry seed and the yield per acre, and also to obtain seed for next season, I did not consume much in a green state at the time they were in the best state for feeding.

I had some ewes penned on a portion of the crop for a few nights, giving them a fresh piece every night; and they made good work, eating all but the main stem, which at this time (first week in September) was rather hard. At this time there was a show of abundance of seed, but the season was too wet and cold to ripen it. When I had given up all hope of obtaining seed, I again put the sheep on the lupines (this was early in November), and they cleared off all the leaves and soft branches, leaving only the woody stems. Four yearling heifers in a bare pasture-field have been supplied with a quantity every morning during the last three weeks. They come to this as they would to hay or turnips, and clear up all but the main stem. These heifers have improved since they have had the lupines, which they received instead of hay, the pasture not being sufficient to keep them up in condition. Pigs refuse the lupines.

With regard to the cultivation of this crop, it appears to require no more care than is usually bestowed on peas or beans. Indeed, in this case not more than ordinary care was bestowed upon them. Probably deep cultivation would favour their growth. Thirteen inches is a good width for the drills when the crop is intended for green food; but when intended for the growth of seed, 20 inches is not too wide, and the plants should stand singly in the drills. Perhaps dibbling might be better than drilling.

Before giving you the results of the weighings of green lupines, I must mention that, as the experiment was intended to show the produce of seed as well as of green food, a part of the field was selected where the plants stood wider apart and the crop was not so large as on the greater portion of the field, but

where the seed would most likely be brought to perfection. On the 24th September the produce of exactly 4 poles of ground was taken from this part (without the roots) when almost free from adhering moisture, and weighed:—

	Tons.	cwts.	lbs.
4 poles gave 903 lbs. = for 1 acre	16	2	56

The produce of 4 poles in another part of the field, where the crop was rather more bulky, was also taken and weighed. Here

	Tons.	cwts.	lbs.
4 poles gave 1210 lbs. = for 1 acre	21	12	16

I think the lupine crop is likely to prove valuable on light sandy soils, where there is a difficulty of growing large crops of the ordinary farm-plants. Of the great quantity of green food which it produces I can speak with certainty, and I can express a favourable opinion of its feeding value. If it will produce a crop of ripe seed of a nutritious nature in ordinary seasons, it will become still more valuable.

Next season I shall venture to plant about the middle of March.

James W. Kimber.

Tubney Warren, Abingdon, 27th Nov., 1860.

Report of an Unsuccessful Experiment in growing Yellow and Blue Lupines. By P. H. Frere.

It is with some feeling of disappointment that I put on record results which tend to the conclusion that the lupine is a plant not adapted to all the varieties of dry soil which are indiscriminately called sandy or heath lands. If, as I trust may be the case, it thrives well on fields whose yellow or reddish colour indicates the presence of sand in the most popular acceptation of the word, it does not seem adapted for those black, gritty, siliceous heaths overlying chalk-rubble and chalk which abound in Cambridgeshire around Newmarket.

On my appointment last spring, being anxious to investigate thoroughly for the Society the merits of a plant which seemed to claim attention as being appropriate to soils for which some change of crops was especially desirable, I set aside 9½ acres for the growth of the yellow and blue lupines. The result was a total and costly failure, and my present object is only so far to state in detail the method of my proceeding, that others may be able to judge whether the result turned upon mismanagement or the peculiarity of the last season, or whether my experience is a legitimate warning against a repetition of the attempt on soils really resembling mine.

First, as to the season: it was one which, in regard to all other crops, was singularly favourable for the burning land in question. The wheat grown close at hand was almost the only good piece on the farm ; the adjacent barley was unusually good (between 10 and 11 sacks, worth 40*s.* and upwards, on land worth from 12*s.* to 15*s.* per acre) ; the layers had more than twice their usual quantity of feed ; moreover, the lupines were already on the wane before the season had developed its extreme tendency to cold and wet. I cannot think, therefore, that the season affected the result: and all the more, because for the kindred leguminous crop of tares, when grown on such soils, the rain can never fall in excess.

Next as to management: the land appropriated to the experiment was the last portion of the green rape reserved for feeding the ewes and lambs, until in our bleak district the rye-grass layer was nearly ready to receive them. The flock was liberally supplied with extra keep, and the land was in good heart, as the adjacent barley-crop clearly shows.

The lupines were sown on the 5th of May : 2 bushels of seed per acre, in rows 9 inches apart. On the 12th of May a grass layer was sown over these 9½ acres, in common with the rest of the barley-shift. Shortly the yellow lupines appeared, a tolerable plant ; the blue never came up so as to form a plant from the bad quality of the seed.

By the early part of June there were plants of yellow lupine 3 and 4 inches high, and their roots were more large, fleshy, and long than the stem. At this point they all stopped : those at the upper end of the field, where the chalk was near to the surface, being the first stunted ; those lower down, where the black sand was deeper, soon following that example. From this point the grass layer and weeds gained the ascendancy. In the first week in July the lupines began to die away, and when the layer was fed off on the 23rd of July not a lupine was visible. If it be objected that the layer choked the lupines, I can only say that when tares have in like manner been sown with layer this was not the case ; and moreover, the lupines started with a good lead, if they could have kept it ; and their deep and strong roots, as well as their stems, ought to have maintained their ascendancy but for untoward circumstances.

If this crop is not suited to the place in our rotation which was assigned to it, I hardly know where it can be inserted advantageously ; especially, if it cannot hold its own against a layer, it will be of little service in my eyes, because I am more and more convinced that on heath land, as far as possible, *all the corn should be put in a whole furrow ;* and that in a hot season this mechanical advantage is of more importance than almost

any supply of fertilisers. A chief desideratum, therefore, for these soils is a new plant, that will either form a network of small roots itself, or, at least, not prevent other plants from commencing their career under its shade.

I was disposed to attribute the failure chiefly to the chalk ; it appeared to me that when the tap-root struck on the chalk rock the plant was poisoned. Professor Voelcker does not confirm this view. He writes, "Allow me to suggest that the presence of lime in your soil is not likely to be the cause of the failure which you have experienced. I am not acquainted with a single cultivated crop that is injured in any way by the presence of lime in the soil, and I imagine that a leguminous crop would be the least likely of all to be hurt by lime." He considers that we must look deeper for the cause of sterility which is connected with these black soils, not only in reference to lupines but likewise to other crops, and has kindly promised that he will endeavour to trace out the baneful influence.

Cambridge.

XXII.—*On the Present Aspect of Steam Culture.* By P. H. Frere.

Four years have now passed since Mr. Fowler's Steam Cultivator (in competition with that invented by Mr. Smith, of Woolston), first appeared on the trial-ground of the Royal Agricultural Society at Chelmsford, and again at the adjourned meeting at Boxted Lodge; and it is two years since the 500*l.* prize was awarded to Mr. Fowler at Chester, as the inventor of that "Steam Cultivator, which in the most efficient manner turned over the soil, and was an economical substitute for the plough or spade."

Since that time a very able Essay has appeared in this Journal, vol. xx., 1859, by Mr. J. A. Clarke, giving—1st, a history of the various efforts, made on different principles, to provide a substitute for the horse-plough ; and 2ndly, rendering an account of our practice so far as it was established down to the close of the autumn of 1858. Moreover Mr. J. C. Morton has read before the Society of Arts a very striking and suggestive paper on 'The Forces used in Agriculture,' with special reference to Steam ; and finally, in June, 1860, Mr. Wells, of Booth Ferry House, Howden, read to the London Central Farmers' Club a valuable paper, on which great pains had evidently been bestowed, on 'The Use of Steam Power in Agriculture.'

Moreover, statements have appeared in our newspapers, in which a profit of thousands of pounds was spoken of as realised ; and yet practically steam cultivation is still struggling into notice,

with much of obscurity about its path, with many misgivings on the part of bystanders who consider themselves practical men, and yet with the brightest and, as I trust, the best-founded promise for the future.

It may be questioned how, in this Journal, subjects should be regarded, which are confessedly in a somewhat transitional state, and how far statements should be sanctioned and views admitted which a larger experience may hereafter modify. To this objection, it may be replied—1st, that the principle of procuring a record, however imperfect, of an existing Agricultural Status, has been recognised in our long series of County Essays; and 2ndly, it may be urged that it is more important that the Society should promote the accomplishment of a design by testing statements already promulgated, and by suggesting inquiry on those heads on which information is still defective, than that it should simply chronicle triumphs already perfected.

The object of these pages, then, is to review, however imperfectly, the present aspect of steam cultivation, not with the hope of speaking authoritatively on any of the points at issue, but rather of promoting investigation, and enlisting public attention, in anticipation of the larger experiments and more exact discussion which the next Leeds Meeting promises to afford.

The subject has already assumed far other proportions than those which caught the eye at Colchester and Boxted, where it was held that because (according to an estimate accepted by the judges), the ploughing could be done by horses for 7*s.* per acre, whereas by steam it was estimated at 7*s.* 2*d.*, therefore, that the prize was not won according to the terms specified in its announcement. Most thoughtful men will now admit that the main question before us is—whether clay lands shall, for the first time in the history of civilization, receive an adequate and reasonable amount of tillage; and that one of our difficulties is soberly to estimate the indirect gain to which this improvement will lead, even if the power employed should be as costly, or nearly as costly, as that which it replaces.

Whether we appeal to science or to history, we shall alike be told that, of late, strong soils have been unduly depreciated. The chemist speaks confidently of the stores of mineral wealth locked up in them; and the antiquarian knows well, that when all farming processes were alike rude, the strong soils were the spots most often chosen by the gentry for their residences, and those on which the hand of the tax-gatherer lighted most heavily. Partial improvements adapted to light soils have for some time disturbed this balance; but a capitalist seeking investment in land, if he notes the signs of the times, may even

now see cause to give the preference to strong soils, and that in consequence of the prospect opened for them, by the united influences of improved drainage and steam cultivation.

But whilst the indirect benefit to be conferred on clay soils by the substitution of steam for horse power, should occupy the first place in our anticipations, the prospect of *direct* profit is bright if somewhat ill-defined.

The judges at Canterbury from their calculation on the work done for a short time, under the pressure of competition, estimate that land requiring "rather more than the traction power of 4 horses moving at the rate of 2½ miles an hour," to draw an ordinary iron plough, can be ploughed by Mr. Fowler at the rate of 11 acres per day, at a cost of 4*s.* 6*d.* per acre. On the other hand, the value of the work when done, may be tested by the fact that some spirited owners of a Fowler near Warwick, besides cultivating their own farms, find that their neighbours will gladly pay them 20*s.* an acre for ploughing stiff land, besides providing coal and water, which together cannot add less than 2*s.* an acre, making a total cost of 22*s.* Nor is Smith's Cultivator less highly appreciated—one of its earliest and most practical employers, Mr. Pike, having done work and supplied the use of his apparatus to his neighbours, at the rate of 25*s.* per acre for the double operation of breaking up and crossing, they finding coal and beer.

"Intervalla vides humane commoda."—Surely the margin between 4*s.* 6*d.* and 22*s.* (with probably a not very dissimilar one in the case of Mr. Pike), is sufficiently broad to excite attention and stimulate enterprise; surely it is sufficiently broad not only to ensure a man against those risks and contingencies which beset all human enterprises, but likewise to guarantee a good profit. And yet if we take into account the extra strain, and the risk of breakages and stoppages arising from breaking up a hard pan for the first time to the extra depth of 2 or 3 inches, or if we look to the alternative cost of horse-labour under such circumstances, or to the value of the work when done, which of us will assert that the hirers do not get their money's worth?

But if this wide discrepancy between the theoretic limit of the cost of doing the work and the value of the work when done, augurs well for the development of steam-culture, it likewise shows how very much we are at sea as to the economical aspect of the subject, and how wide a divergence there is between the estimates of the sanguine and interested and the anticipations of the wary or prejudiced. The practical questions which this discrepancy suggests are self-evident; let us then try to examine its origin and diminish its extent, rather than enlarge upon them.

Those who intend to hire will welcome any degree of light that can be thrown upon the subject, whilst those who let out cultivators as a trade will probably stand better with their customers the more thoroughly the subject is gone into.

Before, however, proceeding to examine the question in detail, it may be well to point out certain misconceptions, and unpractical and inaccurate methods of calculation, which, if admitted, cannot but impair the value of the results arrived at.

1st.—We must base our estimate of cost per acre, not on the amount of work done during a short "spurt" at a trial, but that accomplished on the average by competent workmen without overtaxing the engine.

2ndly.—In comparing steam and horse power, we must put to the credit of steam, not the force *generated* by the engine, but that directly applied to the plough or cultivator: the difference between the two being wasted by the uneconomical and complicated means employed in steam cultivation for the application of the power. In short, we must look not so much to the horse power exerted, as to the number of ploughs kept going, and the work done.

3rdly.—As we only credit the horse with what an average animal can do *without overdriving*, we must deal with the steam engine in the same way.

4thly.—When horses are disposed of, the capital saved must be estimated on their average value, not that of the horse in its prime; and in the case of bullocks, the capital saved is their value in working trim, not when made fat.

5thly.—We may, in the problem before us, fairly combine with the cost of the horses that of those implements used by them, for which the steam apparatus offers substitutes, but not the cost of all farm implements used by horses, such as drills, waggons, carts, horse hoes, &c., &c.; and still less, the total dead stock on the farm. If an entry be made on one side of the account of the saving of keep caused by the sale of horses, credit must be given on the other side for the amount of work which they would have done for their keep.

6thly.—In estimating the amount of work that will be cut out for the steam power *at home*, on a farm of a given size, we must not forget that by early and more thorough cultivation by this means we hope to make a good fallow with fewer operations than either valuers or writers calculate on, or farmers execute by horse power.

7thly.—On calculating the cost of a horse's keep, his food has been generally valued at the consuming price, with the exception of corn; for our purpose the corn must be likewise reduced to

that rate of charge, or else the horse must have credit for the value imparted to the manure, by its consumption.

8thly.—The interest, depreciation, and cost of repairs should be charged on the whole year, and not on those days (or weeks) only on which the implements are at work. If the year's work is but small, the repairs may be set at a lower rate, but the interest will remain the same, and the charge for depreciation will not be much affected.

9thly.—Before framing a general estimate based on reports of different degrees of correctness and authority, a good deal of care must be exercised, in scrutinising these constituents, and eliminating their inaccuracies: otherwise, the least trustworthy report will tell most upon the result, and the greater its inaccuracies, the greater will be its individual influence.

To return then to our subject. The elements of which the problem consists are not very complicated, and some points are pretty well determined. We have a large amount of evidence as to the work which may *on an average* be executed in a day of ten hours without straining the engine or over-taxing the agility of heavily-shod farm lads. As to the *quality* of this work there is no difference of opinion—be it ploughing or cultivating it is the best of its kind; and, again, the cost of the labour of the men employed is well known, and deemed satisfactory, inasmuch as it differs little from that required to carry out horse-work.

The cost of coals bears a pretty constant ratio to the amount of work done; practically, when the engine is working at a high pressure, the consumption of fuel seems to be proportionately rather larger, although an interesting law with respect to the latent heat in steam might lead us to a different anticipation.*

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* The law of latent heat as regards steam is very interesting. It would appear first, that $5\frac{1}{2}$ times as much heat is required to convert water at 212° into steam as sufficed to raise it through 180 degrees, *i.e.* from 32° to 212°. $5\frac{1}{2} \times 180$ making 990 or nearly 1000, the latent heat of steam at 212° is therefore estimated as 1000; or, to adopt Bourne's definition from his 'Catechism of the Steam-Engine,'—"The latent heat of steam is 1000, by which it is meant that there is as much heat in any given quantity of steam as would raise its constituent water 1000 degrees if the expansion of the water could be prevented, or would raise 1000 times that quantity of water one degree." Under the common atmospheric pressure, the heat indicated by the thermometer being added to this gives a sum of 1212°, which sum it appears is a constant—that is, under any condition of pressure it represents the sum of the latent heat and of the indicated heat proper to that pressure; in other words, at higher temperatures and pressures the latent heat diminishes exactly as the indicated heat increases.

For example, if we work with a pressure of 45 lbs. on the square inch (= 3 atmospheres), the heat indicated will be 275°, the latent heat 937°, making together 1212°; if with 60 lbs. pressure (= 4 atmospheres), the indicated heat will be 294°, latent 918°, and their sum, 1212°, still the constant quantity.

These observations are adapted from an able account of the steam-engine in Stephens's 'Book of Farm Implements.' The author continues: "From this is deduced the important truth that by no alteration of pressure will a greater eco-

These slightly variable items—the cost of labour and that of coals—exercise a mutually compensating influence on the aggregate of the day's expenses; for, as a rule, wages are higher in the manufacturing districts where coal is cheaper.

The cost of removals lies in a small compass, but will vary considerably in different localities, and at different seasons. In order to deal fairly by the steam cultivator we must assume that the size of the fields and the condition of the roads are well adapted to its introduction.

The more questionable points are:—1st, How much the cultivator must earn in a season, above its working expenses, to pay interest, cost of repairs, and depreciation in value;* and, 2ndly, over how many working days this charge may be distributed. In both these respects, the case of a cultivator worked by a proprietor on his own farm only will differ from that where the implement is let out for hire, and in full work during the whole season. And yet, unless there be definite economical advantages or disadvantages in the one mode of management or the other, the charge per day must be identical.

Another difficulty arises with respect to the actual available power of the engine when economically worked, the difference between nominal and real horse-power being ill defined, and on the increase. On these two elements, the expenses of repairs, &c., and the amount of force acquired, the cost of steam-power depends. When this is determined we have still to compare it with that of horse-power, a power of which the value and efficiency vary considerably at different seasons of the year. And since steam-power will be available as a substitute at those times in which horse-power is in especial request, the latter must be set above its average value for the purposes of our comparison.

An Average Day's Work.

First, in the case of *Fowler's Cultivator.* On strong land five acres of ploughing seems to be a good average day's work, allow-

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nomy of fuel be obtained; but that, on the contrary, the consumption of fuel in raising a given quantity of water into steam is the same, whatever be the amount of pressure." This conclusion is hardly self-evident.

The object being to generate steam-power, and that power depending on its elastic force, and that force on the pressure to which it is subjected, it would seem that any process is economical which with *the same heat* creates a greater force by the agency of "increased pressure;" the *consumption* of fuel may be identical, and yet a great economy may be effected.

Be this as it may, Mr. Fowler's engine at Canterbury did not appear practically to economise fuel by working at a higher pressure than his competitors.

* The expression "wear and tear" hardly represents, in a definite manner, the two separate considerations of the annual outlay on repairs, and that depreciation which is as much due to modern improvements as to the general wearing out of the parts.

ing for accidents and removals. To accomplish this on the very stiffest clays to a depth of five or six inches a 12-horse engine must be worked at times with a pressure of from 70 to 80 lbs. on the square inch: such work costs 1*l.* per acre when done less perfectly by hired horses. The farm of Mr. E. Holland, M.P., in Gloucestershire, is of this nature; and Mr. Redman's wet stiff land near Swindon, seems to come into the same category; as, "this wet autumn, he ploughed for wheat about 4½ inches deep at the rate of 5 acres per day, using 3 furrows," with a 12-horse engine.

Mr. J. King, in Warwickshire, states he can plough from 5 to 6 acres of clay from 7 to 8 inches deep, and from 7 to 8 acres of light land 10 inches in a day, with a three-furrow plough and a 10-horse-power engine; as this plough is in constant work for hire, the attendants are, probably, more experienced and alert than common labourers.

In less tenacious clays, a 10-horse engine, worked only with a pressure of from 45 to 50 lbs. on the square inch, will go over the same extent of ground to a depth of 7 inches. Such is Mr. Saltmarshe's experience in Yorkshire. In these cases a question will arise whether the fourth plough should be removed that the work may proceed at a quicker pace.

Mr. Saltmarshe is of opinion that the rate at which the steam plough should travel should be not less than four miles an hour, whenever this speed is readily attainable. But he is also an advocate for working with moderate pressure, and says the pressure-gauge should be set at 60 lbs.; so soon as this pressure is indicated it becomes desirable to take off a plough. Probably, the five acres may be alike accomplished by four ploughs working at a lower, or three at a higher speed;—the latter course being preferable.

On loams combined with chalk, at Fawley Court (Mr. Majoribanks), 6 acres of good 3-horse work were executed at a depth of 6 or 7 inches by a 10-horse engine, on an average deduced from 405 acres.

Mr. R. Stratton, of Broad Hinton, with a 12-horse power engine, could probably show a higher average, as he has frequently in summer ploughed at the rate of an acre an hour.

Besides turning a furrow, Fowler's plough will subsoil to a total depth of 14 inches, when deep autumn cultivation for roots is desirable. In this manner, 2½ acres, or half the quantity ploughed, may be gone over on clay soils in a day.

This seems an admirable mode of working the land; better than attempting to turn over a very thick block of clay to be weathered.

Mr. Arnot (on whose farm, near Carshalton, the steam-plough was at work during the Smithfield show), in preparing for roots

in 1859, ploughed 4½ acres per day to a depth of 12 inches. This was on a free-working sandy loam capping the chalk.*

Fowler's Cultivator for breaking up fallows and wheat stubbles.—Under this system the plough is generally preferred to the cultivator; although Mr. J. King finds, in Warwickshire, that the smashing up of all seeds at midsummer, and of wheat and bean stubbles after harvest, is especially approved of by those who hire his implement, although it does not appear either that his charge is lower, or the area tilled larger, than where the plough is used. When the cultivator is used to cross work already ploughed, it is calculated that it will go over nearly 10 acres, but some authorities state that dragging only 4½ inches deep may be effected more cheaply by horse than by steam power. When a bean stubble is broken up, the quantity stirred will be about 7 acres.

Mr. Smith's Cultivator.—With this implement and an effective 8-horse-power engine provided with a double cylinder, working on strong land, about 5 acres of layer or stubble may be smashed up to a depth of 7 or 8 inches in a day; in crossing the same work 8 acres may be got over. This statement is based upon Mr. Smith's own estimate, corroborated by Lord Hatherton, who gives a general average of 6 acres at a depth of 12 inches on a lighter soil; of Mr. Pike, who, speaking from long experience, assigns from 5 to 6 acres to breaking up to the depth of 7 or 8 inches; 8 acres to crossing; and from 10 to 12 to scarifying at a lesser depth with this cultivator also. When dragging is to be subsequently done at a less depth, practical and experienced owners sometimes prefer horse-power.

When one of these implements, belonging to Mr. P. Faux, was tried on Whittlesea-mere—on that light peaty soil as he informs me—it stirred 12 acres per day to a depth of 7 or 8 inches, and that without going into the field.†

Thus we arrive at the conclusion that, on the average, the cultivator does not accomplish much more than half the work indicated as the theoretical maximum attainable. Is this surprising? Does not the analogy of steam-threshing bear it out?

On the Amount of Work done in a Season.

Let us consider this question rather from the point of view of a farmer who confines himself in the main to cultivating his own farm than that of an owner of a cultivator let out for hire.

In that case the amount will be limited, 1st, by the season

* Unless the supply of manure at hand was large, perhaps a greater weight of roots would have been grown if the furrow-slice had not been so thick, and a subsoiler had worked below.

† In this district excellent new roads have been made, whilst some of the adjacent fields will hardly bear a horse's weight. Such a cultivator, *on broad wheels*, is specially adapted for such a locality.

adapted to the work, and, 2ndly, by the extent of work which existing occupations can commonly provide.

The autumn season is the most important. With a few stolen days in August, and 20 days on an average in September, October, and November severally, 65 working days may probably be secured, and a not less number in March, April, May, and June, or more, if more be *then* required—making in all 130 days in a year. But would as many days as this be often required?—because here the superior efficiency of operations performed by steam-power comes into play. I have Mr. Saltmarshe's authority for saying that 90 days' work would suffice for the steam cultivation on 500 acres of land of any kind with one of Fowler's 10-horse engines. Mr. Holland assigns (approximately) 90 days to the cultivation of 400 acres of arable of an unusually tenacious quality. On Mr. Saltmarshe's estimate 130 days would suffice for upwards of 700 acres of arable, a very large holding on those strong soils which we are specially considering. It is for this "culture on a great scale" (to modify a French phrase) that Fowler's plough is specially adapted; here there will be breadth in every arrangement; the engine will not generally interfere with the fixed machinery in constant requisition at the homestead, and roads, fields, ponds, and watercourses will adapt themselves to new requirements. But what is the total of these first-class occupations? To secure a market we must include the 2nd class, say of from 400 to 500 acres, on which this economical question will arise,— Will you have a powerful engine to despatch your work in 80, 90, or 100 days, and then make itself generally useful where it can?—or will you descend to an inferior power?

In the first case, the work will be most seasonably and effectually done, and with less manual labour; but more capital will be called for—and, therefore, unless a contribution is received in consideration of the other uses to which the engine is put, the items of interest and depreciation must press rather heavier on the cultivator. In the last case, the owner may find that though he is sufficiently armed at first, still as our ideas and modes of action extend and enlarge, he may before long wish he had a little more steam at his command.

It is, therefore, the wisest policy to get power enough, though 80 or 90 days in a season may suffice to do the work *now* assigned to the steam-engine.*

In the case of Smith's Cultivator, Mr. Pike considers that 90

* In confirmation of this view it may be asked, How much, in these days of elevators, double-dressers, and the combined threshing and chaff-cutting, is a fair eight-horse-power second-hand engine depreciated in comparison with a six-horse-power engine that can simply thresh?

days' work suffice for his 350 acres of strong arable land; at that rate, 100 days would be nearly enough for 400 acres; and assuming that, on an average for both smashing up and crossing, 6 acres form a day's work, the whole amount of tillage effected would be 600 acres, as large an account as is generally given of a year's performance, although Mr. F. T. Robertson, near Howden, cultivated 788 acres 8 inches deep between April and November 23, 1859; and Messrs. Armstrong and Topham, in a season and a half, between August, 1858, and November 26, 1859, broke up 636 acres and crossed 330.

We may, therefore, assume that Smith's Cultivator will generally accomplish its task in about 100 days on occupations of the size and nature for which it is best adapted; that is, good-sized clay farms, provided with moderate roads, where there is no fixed steam or water power, and, consequently, the engine may be worked for about 60 days in a year for other purposes than cultivation; two-thirds of the cost of the engine being charged against cultivation, and one-third against other lighter uses which will sometimes be little more than *exercise.* This arrangement will generally suit any but the needy farmer who forces his corn into market directly after harvest.

The cultivator, then, be it Fowler's or Smith's, will generally accomplish its task in about 100 days in each season. In either case, if there be no other steam-power, more than half as many days, but not more than half as much force of the engine, may be employed on other farm work, in which case the cultivation will pay all costs arising for the tackle, but only two-thirds of those incurred for the engine.

The Cost of Manual Labour and Water-Cart.

On this head we shall see that theoretical estimates are rather in excess of the cost practically incurred.

For the Fowler, the Chester Report estimated these items at 18*s.* per day; Mr. Holland sets them at 14*s.* 9*d.*; Mr. Saltmarshe, for labour 12*s.*, for water-cart 3*s.*; Mr. Risman, at 12*s.* for men, or, including 3*s.* for horse in water-cart, 15*s.*; and these instances may suffice.

For Smith's cultivator, the average cost of manual labour seems slightly to exceed that of Fowler's. The Duke of Manchester sets it at 14*s.*; Lord Hatherton at 16*s.*; Mr. Pike at 11*s.* 8*d.* (besides beer, about 2*s.*); and Mr. Faux at 15*s.* Perhaps 15*s.* per day may be considered the average, but to this possibly must be added 3*s.* for the horse used in water-carting. The Chester Report assigns 1*l.* 1*s.* to these items. The evidence of experience is in this case decidedly to be preferred.

But the chief cause of the difference between the estimate 18*s.* and 15*s.* is worthy of notice.

The Chester Report provides for a trained engineer at 5*s.* per day; practically an intelligent farm-labourer at 3*s.* is employed, and, on the whole, with good reason, though probably the saving in wages may be attended with some increased cost for repairs, arising from imperfect management.

The extra cost of 2*s.* per day does not nearly represent the cost of retaining an engineer. We have seen that for cultivation the engine will not be generally required more than 90 or 100 days in a year; if 60 or 70 days of work done for other purposes be added to these, the aggregate will still be under 200 days, and for 100 working-days more the engineer will be a dead weight.

On 200 working-days, then, an engineer will cost 2*s.* extra, or 20*l.*, and on the remaining 100 days, even if he makes himself useful, and earns 1*s.* 6*d.*, the difference between that sum and 5*s.* will come to 17*l.* 10*s.*, making the total extra cost for a trained engineer 37*l.* 10*s.*, or, supposing he can help in harvest, 35*l.* at least.

When we come to the item of repairs of engine, this consideration will again come before us. These, it may be, from less skilful management and rougher work, will have to be set at 20*l.* a year (or about 5 per cent. on 380*l.*, the price of a 10-horse engine) above the allowance usually made for machinery, and yet such an arrangement may be the most economical that the circumstances of the case admit of, for we see that the extra cost of an engineer would amount to nearly double that sum, or 10 per cent. on the engine.

For coals the theoretic estimate of 1*s.* per cwt. on half a ton is the safest, for the average cost of delivery on the spot must not be overlooked.

Farmers will do well to consider the difference in the power of different qualities of coal to generate heat—their *evaporative* power.

Thus, according to Stephens* (1964), Newcastle caking-coal takes 8½ lbs., nearly, to raise a cubic foot of water into steam. Staffordshire takes more than 11 lbs. Different Welsh coals stand to one another in the extreme relation of nearly 6 to 10 in respect of their heating powers. Mr. Stephens wisely suggests that our agricultural societies should institute experiments "as to the evaporative powers and best method of management of the various qualities of coal used in our agricultural districts."

It may be asked, in connexion with this item of the water-cart, how much water will generally be required in a day? The

* Stephens's 'Book of Farm Implements.'

most concise answer which I can give is that, according to Bourne,* 1 lb. of coals will generally raise from 6 lbs. to 8 lbs. of water into steam (1 lb. of the *best* coals will suffice for 9½ lbs. or 10 lbs. of water).

A rough calculation may be based on this information, allowing a good deal for water wasted.

Cost of Removals.

Here, again, practice gives in a lower estimate than theory, the former allowing at the rate of 2*s*. a day, the latter 4*s*.; the difference between a dry and wet season will perhaps cause a greater discrepancy than this.

On this head a self-propelling Fowler will perhaps cost as much, for *assistance*, as a horse-drawn engine adapted to a Smith, for draught. The former will require the aid of from 2 to 6 horses, according to circumstances: if we take 4 as the mean, and allow for a removal once in 4 days occupying half a day, the resulting average charge of 1 horse for half a day may be set at 2*s*.

The sum of these items for Fowler's plough would be—

	s.
Labour of men and water-cart	15
Coals *delivered*	10
Removals	2
Oil	1
	28

or 28*s*. per day.

Cost of Steam Power.

We now come to that which I cannot look on otherwise than as the most obscure, as well as the most important, feature in our subject. A writer familiar with the ever-varying conditions of horse-labour as it exists, and not equally experienced in analysing the various elements on which the total cost of steam-power depends, or fully able to anticipate the various modifications of our system to which its introduction will lead, may be struck by the neatness and simplicity of the estimates of cost which accompany the accounts of steam-trials, and hardly perceive that, on a purely theoretic basis, estimates of horse-labour might be prepared equally simple and precise, and probably not less wide of the mark.

As to the defects of these theories of cost:—1st.—The day's work calculated by rule of three from a short trial probably does not represent the average day's work of the season any more nearly than that of the steam threshing-machine can be deduced

* Catechism of the Steam-Engine, Question 146.

from noting the time required to fill a few sacks without interruption—an instance which may perhaps serve us for a guide as well as an illustration. The reputed average day's work is here practically fixed at 70 sacks, by the alternative offer commonly made to the hirer, of 35*s.* per day, or 6*d.* per sack; although in theory 10, 11, or even 12 sacks may be threshed in an hour: so that the day of 10 hours ought to produce half as much work again as is practically accomplished.

2ndly.—These calculations are commonly based on the estimate of 200 days' work done in a year; but under what conditions (especially with great dispatch of work) is such an amount of employment to be reckoned on? If on the lands occupied by the owner, must not that occupation be quite exceptional? if on the lands of several occupiers, will not the condition of hiring be introduced, and necessitate the revision of many items in consequence of the greater cost of removals and the less economical conditions under which the workmen (and perhaps the engine itself) are engaged?

In making these calculations it must not be overlooked that, supposing book-estimates to be right as to the amount of ploughings, draggings, harrowings, rollings, &c., which went to making a fallow, not on foul spots only, but throughout the shift, yet that the operations performed by steam-power being more effectual, will be fewer in number. Consequently, whether I demur or not to such an estimate stated as an axiom, as that a farm of 600 acres has 1000 to be ploughed annually, I cannot anticipate that for steam-power the same amount of work would be provided on that area.

The number of days' work, then, which will be furnished in the year on such a farm will have to be diminished, but the annual charge cannot be reduced in like proportion, and must therefore be assessed at a somewhat higher rate upon each working day.

It is very easy to say, set down 15 or 20 per cent. on the outlay for wear and tear, that being the general allowance for machinery; but how different are the nature and prospects of those different objects which come under the common name of machinery! Some machines are so thoroughly established that we can fairly reckon on their being worn out before they are laid aside. In other cases the manufacturer is indifferent about their export, because he feels pretty sure that they will be superseded at home before they come into general use abroad. Again, machines (even twins) differ as much in quality and durability as any two horses, and in the smaller class it is harder to strike an average. Again, how much depends upon usage and management, and yet in our case it has been shown that agricul-

tural machines are entrusted to rough hands for rough work, and that it is not worth while to arrange otherwise, even if an extra 5 per cent. on repairs is involved.

Before we come to particulars, let us look at the experience derived from steam-threshing. In this case the united cost of engine and drum is a little over 300*l.*: the former, costing two-thirds of the outlay, is a well-established machine; the latter, costing one-third, still in a state of transition. The repairs on each probably bear about an equal proportion to their prime cost. The two are commonly let out at 30*s.* per day; if they are severed as much is charged for the 100*l.* drum as for the 200*l.* engine. Thus the charge of joint hire is 1-200th of the whole cost, but that on the drum alone 1-133rd, at this rate of charge. An owner would probably charge himself 10*s.* instead of 15*s.* for home use of either at leisure times. I have been challenged to point out owners who have made money by letting threshing-machines, and this challenge from a well-informed quarter went to show that success is not general or profit excessive; it could not be taken up, because those who had managed best and had most experience, had no accounts to show. I think myself happy in meeting with one exception in Mr. Turnill, of Sawtry, and make the following extract from a letter written by him to Mr. J. M. Heathcote for my information:—

"We have three portable engines of 8-horse-power each, with threshing, shaking, and winnowing drums with each; one, bought in 1856, the engine cost 255*l.*, the drum 120*l.*, together 375*l.*; the second, bought in 1857, the engine cost 256*l.* 5*s.*, the drum 128*l.*, together 384*l.* 5*s.*; the third we bought secondhand, in 1859, at less than half the original cost, but it cost near 100*l.* to put it in repair, because it had been badly used. With respect to the repairs of the two we bought new, the first two years of working the repairs on each engine amounted to 10*l.* per annum; on each drum, 12*l.* 10*s.*; for the third and fourth years each engine has cost 30*l.*, and each drum 20*l.* per annum; making an average for the four years of 20*l.* for the engine, and 16*l.* 5*s.* for the drum. I have no doubt, however, that the repairs in the next two years will be greater than in the two last, as many of the parts want replacing. Besides all repairs, I believe that from 10 to 12½ per cent. per annum may be set down for depreciation, as in the course of 10 or 12 years they will be unfit for use. Mr. Frere must bear in mind that our engines are let out on hire, and are continually in work for eight months in the year, which will increase the repairs and depreciation over those that are only used by a gentleman on his own farm. A very great deal depends on management of machinery as to cost of repairs."

From this I should infer that the cost of the third and fourth years are not above the average of the whole working period. The results of my own experience were recorded in the last Journal. I find that, after deducting oil, the repairs on one engine and drum on the average of two years, 1857-58 and 1858-59, amounted to 33*l.*, or say 30*l.*=10 per cent. on 300*l.*; to this must be added for depreciation of engine, at 10 per cent.

20*l.*; of drum, at 15 per cent., 15*l.*; if to this we add 15*l.* for interest, we get a total of 80*l.*, or more than 25 per cent., for repairs, depreciation, and interest on a pair of machines which were hired for about 160 days and used at home ($\frac{80}{2}$) 40 more. In this case the cost of straps is considerable, and analogous to that of the rope in steam culture; it is also capricious, because good straps have been sold at different prices in different quarters.

Let us now consider in detail the component elements of the most complete of steam-cultivators, Fowler's 12-horse engine, with tackle to match. The outlay may be thus classed:—

		£.	s.	d.
For engine		420	0	0
For rope, 800 yards		90	0	0
Windlass, anchors, rope-porters, &c., &c.		189	0	0
Plough, 4 furrow	£81	101	0	0
Extras for cultivating or subsoiling	20			
		£800	0	0

For an agricultural engine in full work, I have hazarded the opinion that 10 per cent. will be required for repairs, 10 per cent. for depreciation, and 5 for interest, which on 420*l.* amounts to 105*l.* in all. Not anticipating that for cultivation the engine will be used more than 100 days in the year, but that the work will be severe when in hand, I would charge the steam-engine with two-thirds of this sum, or 70*l.*

The rope is the next point, and a difficult one. This item will be more costly on clay-capped chalks, where the presence of flint-stones must increase the wear and tear, than on homogeneous clays. When the plough is travelling at nearly 4 miles an hour a good deal of vigilance will be required to have the rope-porters properly looked to; if the farmer fails to do this, the implement maker ought not to be blamed for the result. Perhaps the wages of an extra lad will be money well spent.

On these chalky loams, where 6½ to 7 acres is a good day's work, the cultivation of 800 or 900 acres at first went very far towards wearing out a rope; these were probably of inferior quality, and it would not be fair to assume that a 90*l.* rope would now be used up by that amount of work. There are however, instances where the rope has cost 1*s.* 9*d.* per acre, or nearly 12*s.* per day; but such improvements in its manufacture and mode of attachment have been made that I propose to estimate the average daily cost at 8*s.* per day, or 40*l.* on a season of 100 working days, calculating that the rope will plough henceforth between 1100 and 1200 acres of the stiffest clay. This 40*l.* is only 5*l.* in excess of Mr. Fowler's own estimate of 35*l.*, besides a sum for contingencies.

Coming next to the gearing, windlasses, anchors, rope-porters,

&c., some of these are very durable; other small fittings, such as india-rubber springs, are the reverse; some are open to improvements and changes; and some well established. A less rate than 20 per cent. on 189*l.* (about 38*l.*) can hardly be assigned to the interest, repairs, and depreciation of these auxiliaries.

Lastly, we have about 100*l.* for a plough, shares, mouldboard, prongs, &c. Under this head 5*l.* will be required for interest; probably *not less than* 5*l.* for new breasts, shares, prongs, &c., and 5 per cent. for depreciation.

Thus the steam cultivation would be charged:—

	£.	s.	d.
For steam-engine (2-3rds of full season) ..	70	0	0
Rope	40	0	0
Tackle	38	0	0
Implements	15	0	0
	£163	0	0

To levy this charge it must be assessed upon—

	£.	s.	d.
100 days at the rate of about	1	12	0
The labour of men and horses, coals, oil, &c., has been valued at	1	8	0
	£3	0	0

And we thus arrive at a total charge of 3*l.* for a day's work.

In this scheme some may think the steam-engine highly charged. I have given my reason why, on the very scanty information now before us, it can hardly be set lower. On loams, the charge of the engine may perhaps be reduced, because there its powers will not be so severely taxed; but, on the other hand, the cost of the rope may there be in excess of our estimate.

A charge of 1*l.* 12*s.* is at a lower rate, too, on such a steam-cultivator than that of 1*l.* per day—the sum I should charge my own farm as owner—for a threshing apparatus.

Thus I have ventured to raise the charge for the use of Fowler's machinery 50 per cent. on former estimates of writers, yet I am confident that, if these calculations are sound, so far as they go, they will promote the employment of this agent, because so powerful an implement when in its right place, if charged 3*l.* per day, will easily earn more than 5*l.*

In the case of a 10-horse power engine the annual cost might probably be reduced 23*l.*, chiefly on account of the diminished cost of the rope and strain of the engine; leaving 140*l.* to be charged on 100 days at the rate of 1*l.* 8*s.* per day.

Smith's Cultivator.—Mr. Smith's apparatus consists of 8-horse power engine, 255*l.*; rope, 1400 yards, 61*l.*; windlass, anchors, snatchblocks, rollers, &c., 135*l.*; turning bow, 21*l.*; No. 3 cultivator, 16*l.*; No. 4 cultivator, 17*l.*: the whole costing 505*l.*

Of this outlay the engine, such an one as is most suitable for general purposes, costs one-half; all the remainder of the apparatus beside the rope is described by Mr. Pike as very durable,—an opinion more or less corroborated by the evidence of other owners.

With respect to the rope, although placed under different conditions, its wear and tear seem to have ranged between nearly the same limits as in the case of the Fowler; ropes have been almost worn out by the cultivation of 800 or 900 acres; have cost 6*s.* per day, &c. &c.

The substitution of steel for iron in their manufacture seems, however, to have been a decided improvement, and to promise better average results for the future.

Although the rope used by Smith is much longer than Fowler's, still from the less strain put upon it, and its consequent less thickness, its cost is smaller.

Careful management will probably much diminish the wear, if the rope is neatly coiled round the windlass and not allowed to "kink" after being slack; and there is no risk, as in the case of the Fowler, of the rope being allowed to grate along the land side of a stony furrow.

In either case, how much of the wear of the rope is due to the soil, how much to the machinery, how much to a close-biting grip, and how much to the risk of the slack rope, how much to the pulleys and changes of direction which the engineer will notice, and how much to contingencies which practice and observation will alone discover—all these must remain as points for further investigation; at present we can only charge Smith's cultivator for rope at the same proportional rate as Fowler's.

The account will stand thus:—

	£.	s.	d.
Engine, 2-3rds of 25 per cent. on 255*l.*	42	0	0
Rope, 61*l.*	27	0	0
Windlass, anchors, &c., 15 per cent. on 135*l.* ..	20	0	0
Cultivators, and turnbow, 15 per cent. on 54*l.* ..	7	10	0
Shares, &c...	5	0	0
Total	101	10	0

or say 1*l.* on 100 days.

If to this sum 26*s.** be added for the daily expense of men, coals, oil, &c., the total charge against Smith's cultivator will be 46*s.* per day, at which land may be broken up for 9*s.* 3*d.*

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	s.
* Labour	15
Coals	8
Oil	1
Removals	2
	26

per acre, and crossed for 5*s*. 9*d*. per acre, or the double process accomplished for 15*s*. per acre at a depth which will vary from 7 inches on clays to 12 on loams.

On the Cost of Horse-power for Ploughing and Scarifying.

We have now to consider what the same work would cost, if done by horses. It had been designed that the general economy of horse-power should have been discussed in a separate article in this Journal, its importance demanding a distinct notice; but as this intention has not been carried out, I must touch on the subject, confining myself, however, to that portion of it which is essential to our present purpose. This will be more safe than to adopt the broader conclusions of a general statement; for, at the best, agricultural generalizations are so rude, that it is not often desirable to supersede special investigation by the assumption of a formula.

In our case there is to be considered the cost and efficiency not of the average horse at average work, on the average of the year, but of the stout horse adapted to clay land, only when ploughing or cultivating, and at those seasons in spring and autumn when the demand for horse labour, and consequently its value, are far above the average. Now the heavier clay horse costs rather more to buy, and a good deal more to keep than that adapted to light soils; there is some ground also for doubting whether his traction power in a plough does not considerably exceed that assigned to him by theory, although that theory, we are told, was based by Stevenson on the performances of heavy London horses.*

* Mr. Morton has shown that 33,000 lbs., lifted one foot per minute, is equivalent to a draught of 150 lbs. where the horse is working a plough at the rate of $2\frac{1}{2}$ miles per hour. Now, at Canterbury the average draught on the lightest four-horse plough was over 800 lbs., or 200 lbs per horse. Were, then, the horses going at a less rate than $2\frac{1}{2}$ miles per hour? At a subsequent private trial, three horses with an iron plough competed with these four-horse Kentish ploughs. Did not these three exert a force considerably in excess of our theory?

In Mr. Morton's calculations so much depends upon the number of pounds lifted 1 foot high per minute which is equivalent to the average efficiency of the horse, that it becomes important that one arithmetical mistake in his Article (Journal, vol. xix., p. 464) should be corrected.

The annual horse-labour on Whitfield Farm, says Mr. Morton, amounted to 37,106 cwt. drawn (= lifted) 1 mile per annum; and he continues, "For the words 'per annum' we may substitute 300 days of 9 hours each, and the work done will be found on calculation to have been equal to the lift of 135,450 lbs. 1 foot high per minute during all that time, which, *as 7 horses were employed, was* 16,492 lbs. a-piece." Now 135,450 lbs. (the correct aggregate) divided by 7 gives, not 16,492 lbs. as there stated, but 19,350 lbs., that is to say, a larger amount than that given elsewhere in round numbers as the maximum that was known in one instance only (Mr. Melvin's) where the cartage was clearly excessive.

If in the Whitfield schedule some of the work, such as root-carting, is set at a high estimate, on the other hand on every farm the horses have to perform a certain amount of what may be called estate-labour, in carting materials for roads

Again we have to do with the efficiency of the horse in ploughing and cultivating only, which may be above the average, in consequence of his labour when applied to other farming purposes not being equally effective; but then unquestionably the efficiency of the steam-engine for ploughing and cultivation is above that which it could exhibit at other farm-work, which at present it does not venture to undertake.

But above all the season is to be considered at which the work is to be executed: this tells upon all farms, but *very much more on heavy than on light lands.* To illustrate the amount of variations in different months which may be considered to exist on the former soils, in the demand and consequently the value of horse-labour, I venture to quote a most striking passage from Mr. Morton's paper on the Forces used in Agriculture.

"On examining the horse-labour of a farm of 240 acres of arable land under alternate husbandry, it will be found that it does not much exceed 500 days of a pair of horses in the year, and that the need for it is distributed among the months extremely unevenly. Not more than 35 days of a team per month are wanted in December, January, and February; about 45 days a month are wanted in March and April, May and June; about 15 days are wanted in July; about 60 in August, and 90 in September; and 55 in October, November, and December. August and September stand highest; and as there are not generally more than 24 working days in each of these two months, there must be a provision of at least three and a half pair of horses all the year, in order that the work of August and September may be done. Now, the two-fifths of the horse-labour which is proper for steam-power, is not going merely to displace two-fifths of these seven horses through the year; for the ploughing and cultivating being done by steam, will take not two-fifths, but more than half of the labour of the encumbered months of March and April, May and August, and September and October, and so reduce the amount to something like 35 days' work during each month of the year, which two pairs of horses will more than easily accomplish."

I quote from the Bath and West of England Journal (vol. viii., part ii., page 303), without knowing where the error of mentioning December twice, originates. Assuming that the last mention of that month ought to be erased, we shall have a total of 560 days' work for a pair of horses in a year, or 1120 for one horse on a farm where 7 were kept, and according to the theory of 4 to 100 acres arable, 9 at least ought to have been kept: these 9 (on Mr. Morton's hypothesis) being capable of doing 300 days' work apiece, or 27,000 days in all in the year.

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and for repairs of buildings, draining-tiles, timber and brushwood, coals, &c., in addition to the direct farmwork there detailed. Moreover, although the amount of traction on farm-roads seems as ably and fairly calculated as circumstances admit, perhaps it is rather understated for the rough, wet season to which so much of this work is practically postponed,—an error, if it be one, which is compensated by estimating that the cart weighs as much as its load, which is hardly the case with improved carts, my own 2-horse Croskill's not weighing much more than half the load they commonly carry. On the whole, then, the aggregate here given of work done in the year gives a total which it is not easy to amend.

I am not prepared to endorse this statement: it is not self-evident to me how it arises out of the schedule of work executed on the Whitfield Farm, given in Journal, vol. xix., page 464.

As a light-land farmer, I have known that, though our demand for horse-labour is unequal, the clay-land farmer has to provide for much greater inequalities. But I can hardly think that, practically, even clay-land farmers have more than twice the power on their farm that they can beneficially employ; and if any man came to me saying "I have thoroughly ascertained that such are my circumstances," (apart from the question of steam-culture), I should be disposed to answer, "Surely you could revise your scheme of management a little, so as to make it more economical."

Whether, however, we take this estimate to be conclusive as it stands or not, it is most suggestive, as pointing to the great advantage of occupations including a variety of soils, on which, if well managed, a portion of sandy heath may be cultivated at very little extra cost, so as to leave hardly more than three or four idle weeks in a year; as putting in the strongest light the value of a subsidiary agent, which costs but little except when at work; and—which is to our special purpose—as justifying a rate of charge much above the average of the year for those months in spring and autumn where steam may be a substitute for the horse.

In farming calculations, I am disposed to set almost every item at a rather lower rate than is generally found in agricultural treatises, in which hardly a sufficient distinction seems to be made between what *may* be done under favourable and exciting influences, and what *is* done on the average of farms and seasons. A distinct service is rendered to Agriculture when its maxima are brought under our view *as such*, to gauge our short-comings, and stimulate our energies; but the very consciousness of what may be done, and the ability to accomplish more than is commonly done, may lead men to over-estimate average performances.

Indeed we do not generally even attempt to do all we might do, and that for a sound economical reason,—our primary object being to distribute the labour of both man and horse over the year with as little inequality as may be.

To this end, although in harvest-time it is common for a man in one day "to pitch in an hour's time an acre of a good crop of wheat, tied in sheaves, to an average height of full 6 feet, on the cart or waggon"—and, "straw and corn together, such a crop will weigh more than 2 tons, say 5000 lbs.," and "in doing this he therefore lifts 300,000 lbs. one foot high in ten hours' time, or 5000 lbs. per minute"—to quote one of Mr. Morton's illus-

trations of hand-power, it is by no means common to see the preceding illustration put in practice, according to which "three men will lift 100 cubic yards of farmyard-dung, and fill it into carts in ten hours' time. The 33 cubic yards which fall to each man's share, at about 14 cwt. a-piece, weigh 50,000 lbs., and this is lifted over the edge of the cart, or 4 feet high, equal to 200,000 lbs. lifted daily one foot high, or 330 lbs. in a minute."

So long ago as in 1843, Mr. Pusey pointed out in the Journal, vol. iv. p. 315, that "whereas a labourer commonly filled eight or nine loads per day, measuring $1\frac{3}{4}$ cubic yards apiece, he might very well fill ten such loads by two or three o'clock;" and yet farmers generally keep on at the old jog-trot pace; and why? Because it is the work of leisure-time and off-hands, and, as far as expense goes, it is a matter of indifference; either way the cubic yard will cost the farmer about a penny for filling, and he does not want to hurry over his work when he has time before him, and perhaps each cart requires an extra horse, from the wintry state of the roads.

I have ventured to introduce this illustration of my meaning, taken from man rather than from horse-power, because it is the most precise which offered itself: we have what might be done, and what was done, both distinctly stated on good authority. I venture to affirm that no general change has taken place since 1843, and so we have men day after day filling about 15 or 16 cubic yards, when they might fill 33, and consequently working half-strength at the slack season.

This equalization of labour is, indeed, a principal point in the economical management of land, without which neither skill in producing good crops and stock, or vigilance in seeing that work is properly done, suffice to produce a good balance-sheet. It is a key which may explain to outsiders why shrewd practical men are often slow to adopt a hint which is good in itself. Such men wait to think what effect the new device would have on their general scheme, and if it causes general derangement, or calls for labour at a busy time, they instinctively reject it, without exactly defining the higher *rate* of charge for extra cultivation, which ought to stand on the debtor side of the account, to the probable disturbance of the balance of profit and loss. Hence also farming operations are often not performed at the very best moment in the abstract, and that wittingly; because prudent farming, like statesmanship, contains much of the element of compromise.

In the case of the horse, attention to this principle is enforced by palpable self-interest. The market-price fluctuates so sensitively, that it is at least as cheap to hold, as to sell in

the dead season, with the prospect of buying again; and the horse, if kept, must be fairly kept up, and may as well do some work for his livelihood. The man, feeling some of the draw-backs as well as advantages of not being a "chattel," has to trust to kindness and discernment, with the poor-law in the back-ground, to save him from destitution;* and for his sake it is specially important that wisdom and humanity should combine to check a disposition to short-sighted saving, and, by a happy adjustment of farming operations, secure him steady employment.

In this point of view one detail connected with steam-cultivation is really a misfortune, rather than, as it has been commonly regarded, a matter of congratulation. Most writers have stated correctly and with satisfaction that nearly as much manual labour is now required in connection with steam cultivation as that done by horses: but if we may rightly assume that this cultivation is to be effected in the six or seven busiest months in the year, I can hardly share their feeling. I should hail with equal satisfaction any auxiliary which offered either to diminish the demand for labour at our busy season, or to increase it at our slack time. We no longer suffer, thanks be to God, from an absolute plethora of strong willing hands; at present our social and moral well-being turn upon the extent to which forces, confessedly not in excess of our wants at one time, may be utilised at other seasons. The more steam-power tends to restore this equilibrium, the more valuable it is. Paradoxical as it may seem, the less the steam-cultivator requires of manual labour, the more it will benefit the British labourer.

To return, however, to the cost of horse-power. I have endeavoured to base my estimates on that which is customary in my part of England; on that custom such considerations as I have just alluded to have probably exerted a greater influence than we ourselves are aware of. By slackening our exertions at times we have more nearly gained continuity of action, and in so doing have acted on sound economic principles, although this slackness has probably become too habitual, so that increased exertion when required *could* not be freely made, from being strange; or *would* not, from suspicion that it would not be duly valued and paid for.

First, as to the number of days' work performed in a year. Allowing for sickness and lameness, &c., and the effects of rain and snow, particularly on clay soils, I do not propose to estimate these at more than 250. Next as to the number of hours' work per day. That management which commonly assigns $7\frac{1}{2}$ hours,

* If he has a garden allotment, he may very well do all the heavy work required to prepare the ground in the late autumn and winter.

with a power of increase at harvest, seed-time, and hay-time, seems, on the whole, economical, particularly as it diminishes the cost of attendance. At these rates the horse will work 1875 hours in a year, to which, if we add for extra work at harvest and seed-time 125 hours, we shall have a total of 2000 hours, which, at 5*d.* per hour, amounts to 41*l.* 13*s.**

The cost of the horse and all adjuncts may be thus calculated:—

	£. *s.* *d.*	£. *s.* *d.*
Food	23 10 0	
Deduct for difference between market and consuming price for corn, 10 per cent. on 10*l.* or more	2 0 0	
		21 10 0
For ploughmen and attendance		12 0 0
For interest and depreciation		4 10 0
For shares and maintenance of ploughs and cultivators ..		1 10 0
For blacksmith, saddler (plough harness only), and farrier		1 10 0
		41 0 0

On the first item I need only observe, that if you keep the horse and have the benefit of his manure, *all* his food must be charged at consuming price.

On the second:—this allowance is liberal, on the system of working in a single journey of 7½ hours, in which case one carter looks after four or five horses, and labourers or lads help him in ploughing. Here 35*l.* a year have been allowed for the carter, and 1*s.* on 250 days, making 12*l.* 10*s.* for assistance, or, in all, 47*l.* 10*s.*, which, divided among four horses, gives about 12*l.* apiece.

The next item is 15 per cent. on 30*l.*, the value of the average of the horses, not of those in their prime. In the other items nothing but ploughs and cultivators and the harness adapted to them are taken into account, because the steam apparatus comprises only similar implements.

A margin of 13*s.* is left, which each reader may add to any of the above items to make them suit his fancy or experience. And thus it has been shown that the annual expense of the horse (with such adjuncts as are included in our calculation of the cost of steam-power) will be met by a charge of 5*d.* per hour on 2000 working hours.

But thus far we have made no distinction between the value of a horse's work at one season and at another, whereas steam promises to replace his services just at the three busiest months in autumn, and then again for three months in spring. We ought not, therefore, to contrast steam-power with the mean value

* This is an estimate adapted only to our special case.

of horse-labour, but with that which it bears at the busy seasons. Now if in consequence of the exigencies of these six months, three horses were kept where two would otherwise suffice, and if these extra horses were utterly useless during the remaining half of the year, the work done by them (for which steam is proposed as a substitute) would cost double the usual rate. But since steam does not offer thoroughly to provide for extra work (viz., during harvest), and the horse can be turned to some account at other times, I propose only to charge for the busy months half as much again as for the slack months, viz., 6*d.* and 4*d.* per hour respectively, maintaining the average of 5*d.* per hour on the whole year. This amount of difference will not, I think, appear excessive, if it be borne in mind that the actual amount of work done will differ with the season, as well as the urgency of that work. For instance, when roads are bad three horses will not be more efficient in carting than two in dry weather.

If it should appear that in halving the year, to simplify our calculations, the busy season is too much restricted, on the other hand it may be thought by some that the cost of the horse is here set rather low, so that a few more days' work, charged at a higher rate, will admit of the cost of keep being slightly augmented. It would seem then that horse-labour, as contrasted with that of steam, may be fairly charged at not less than 6*d.* per hour.

Let us now apply this conclusion to one special case.

It has been estimated that a Fowler with a 12-horse engine will, on the average, plough 5 acres of very stiff clay in ten hours, at a so much greater depth than four horses could attain to, that in theory it may be looked on as 5-horse work.

Four horses would go over $\frac{3}{4}$ of an acre per day; on this all are agreed. How much time would they spend over it? With a 9-inch furrow the distance traversed would be $\frac{3}{4}$ of 11 miles, or $8\frac{1}{4}$ miles. If we allow $2\frac{1}{2}$ hours for about sixty turnings and incidental delays, we shall have 5 hours left for travelling $8\frac{1}{4}$ miles, requiring less than the rate of $1\frac{3}{4}$ miles per hour.* The horses, therefore, may just as well accomplish their task in $7\frac{1}{2}$ hours, as waste more time about it.

The cost of the four horses working $7\frac{1}{2}$ hours, at 6*d.* apiece per hour, would be 15*s.* for $\frac{3}{4}$ of an acre, or 1*l.* per acre. The ploughing as done by steam being equal to 5-horse work, would cost, if practicable for horses, 25*s.* The steam-plough, therefore, costing only 12*s.* per acre, or $\frac{1}{5}$ of 60*s.*, shows again over horses of 13*s.* an acre, or more than half; and even if, to keep on the safe side, we reduce the steam-power's day's work to $4\frac{1}{2}$ acres, the cost will still be under 13*s.* 6*d.*

* The size of the field is assumed to be adapted for steam culture.

Let us for a moment consider where the chief difference lies in the *modus operandi* of these two powers. The heavy horse, it would seem, does not move at the rate of more than two miles an hour; the steam-plough more than half as fast again, or, when it works to the best advantage, even nearly twice as fast. On this, perhaps, the essential superiority of the latter chiefly turns; for whilst in the case of the horse the traction-power is only the residue of the muscular power over and above that required to keep himself in motion—a residue which diminishes as his pace is increased, the fixed steam-power suffers no such diminution when its speed is augmented.

On the other hand, without professing to have investigated the subject, I will venture to believe that the resistance of the soil does not increase in equal proportion to the velocity of the plough, and therefore that the more rapid instrument works at a great dynamical advantage; and I invite attention to this branch of the subject, that it may be considered by those who are adepts at such calculations, as well as tested by experiments, if, indeed, our dynamometers are sufficiently perfected and proved for large pressures, to give us secure grounds of assurance.

In these calculations the work of horses has been chiefly contrasted with Mr. Fowler's steam-ploughing, rather than Mr. Smith's cultivating, because the two first were similar and commensurate, and therefore admitted of far easier comparison; whereas Mr. Smith's first operation would not be generally equivalent to a ploughing, to which the first and second together would be more than equivalent; whilst scarifying, as done by horses, would be too defective to admit of comparison.

It is by no means within the scope of this Essay to attempt to decide between the merits of the two systems; each will have its proper sphere of action, each has merits which within that sphere will rightly give it the preference. The indefatigable energy and skill with which Mr. Fowler has remedied successively the defects in his arrangements as they became apparent, will secure him a high place amongst British engineers and inventors. There is a finish and completeness about his apparatus, a combination of ingenuity and simplicity which is very attractive; but the farm on which it is to work ought to have both finish and size in proportion, in order to do it justice.

On the other hand, whilst the spirit and vigour with which Mr. Smith threw himself into steam-cultivation on a very small occupation, ought in itself to make him a man of note amongst English farmers, — the success which is attending his plan is now indicated by the safest of all agricultural criteria—overhedge imitation.

In at least two or three counties adjacent to his own his system has taken root, and is spreading from several centres.

In the nature of the investment required he has a decided advantage. The engine used is just such an one as would be desirable for other uses. If the rope wears out rather fast, the cost lies within a limited compass; the rest of the tackle is reported by Mr. Pike to be "very durable," and to cost "very little for repairs in comparison with the engine."

Thus, if we assume that the engine already exists on the farm, the rest of the investment and risks are of moderate dimensions, involving an additional outlay of only 250*l.*, of which 100*l.* may probably be replaced by the sale of horses. Moreover, this system, as far as it goes, is adult; if rather more rough, it is ready; and, moreover, fields and roads are, comparatively speaking, ready for it. It is not susceptible of much farther improvement, and therefore not liable to much change.

If throughout these pages the name of the inventor has been used rather than that of the exhibitor of this cultivator, it has been from a desire to give Mr. Smith his due, without putting a slight upon others.

The competency of this cultivator depends chiefly on our ability to prepare for wheat, or make a fallow without inverting the soil, a point on which opinions seem much divided. On the one hand experience reminds us that Mr. Pusey was over-sanguine in the hopes he expressed in Journal, vol. xi. p. 424, &c., of superseding for the future the numerous ploughings of the orthodox fallow, by new and early cultivation, so long as horse-power alone was to be depended on. On the other hand, we must not forget the greater velocity, as well as greater depth, at which steam-power works. If only we can produce such a dislocation and disruption of the soil that the lumps shall not run together again under the influence of wet, we have no longer any object in turning in weeds to plough them out again.

That there are soils and seasons for which steam-power is effectual to this end, where horse-power would be defective, hardly admits of a doubt; the debate can only turn on the limits within which this distinction is applicable: my impression is that ultimately they will not be found narrow.

As regards season, from the middle of June to the end of August, perhaps, there is no soil on which "smashing up" will not make a most effectual and economical fallow. Our laudable pursuit of heavy root-crops has in part put this point out of our sight; it has been recalled to my own observation by a practice of breaking up three-year old sainfoin layer as soon as the hay is carried. This layer is invariably and inevitably

foul, and yet we make a cheaper and better fallow here than on the ordinary wheat-stubble. Instead of having endless harrowings (which break and disperse as many rootlets as they bring knots to the surface), followed by costly and imperfect pickings, we can, with management, leave all but cultivating to atmospheric agencies—the farmer's best assistants after all. If the rain-fall is then considerable, evaporation is very active, and the power of the sun's rays when they shine being very great, the process of withering goes on rapidly, and the land may be stirred at short intervals with advantage.* Under such circumstances the inversion of the soil is not indispensable, if it is not a waste of time. In most seasons this same rule would apply to the month of September, and probably to March, though that is not the time to commence a fallow.

Yet, after all, time and observation will alone decide this question; and the autumn just past was singularly unfavourable for such observations: the few opportunities, however, which I enjoyed, in addition to written testimony, make me hopeful of the result, not only for root-fallows, but also in preparation for wheat on strong soils.

There is yet another aspect of the question which calls for early attention. The difficulties which stand in the way of steam-cultivation are not solely or chiefly mechanical, dependent on the skill and enterprise of the agricultural engineer. In order to pave the way for its introduction, the owner or occupier of land will often find that he has much to do which will require both time and outlay. To deal fairly by the steam-plough, the size, shape, and situation of the fields, and the condition of the roads, ought to be fairly adapted to its use. In many parts this is not now the case, but the movement in that direction is active, and the incentives various and powerful.

Our affair is especially with strong soils: these were the first occupied by the feudal chiefs, the most coveted by their dependants, the earliest distributed, and the most subdivided; moreover they were the natural sites of forests, and these, in some parts, have never been more than partially cleared, whilst in all the timber has not only a tendency to perpetuate itself, but to re-occupy any neglected corner.

Here, too, began and multiplied *ditches*—the feeble precursors of drains—whilst the attendant hedge was the readiest resource for the growth of bushes, where these were wanted either for fire-wood, or to fill the primitive drain before pipe-tiles were in

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* A clay-land farmer, who sows trefoil for early sheep-feed to save his pastures in May, will perhaps find that, after the trefoil has spent itself, he may yet make as cheap and good a fallow as if he had devoted the whole year to the work, and that at a time when he has little to distract his attention.

use. Moreover, where the gentry still occupy the old halls, the timber has been maintained with special vigilance; and where the cold and damp of the spot has driven them to remove, the parish in which they had lived has too often become one of the most neglected, because one of the least attractive, in the district. These influences have in like manner acted upon the state of the roads; or, rather, the natural difficulties which stood in the way of road-making first contributed to the removal of the proprietor, and in days of greater exertion the proprietor's absence withdrew the stimulus which was required to overcome these difficulties.

For such reasons is it that those districts where the presence of the steam-cultivator is most required are too often those least prepared to receive it; and even if, for argument's sake, it be admitted that this method of cultivation is not yet sufficiently perfected and matured to warrant an immediate purchase, still it is important that attention should be specially directed to the subject, that the owner of strong soils may note the rate of progress which it is making, and compare that advance with his own more complicated task of improvement, and ask himself whether the new cultivator will not be in working order before his estate is ready to give it a becoming reception.

And if it be asked what is the progress of the steam-plough,—it may be shown, to speak only of its increased power, that—whereas at Boxted it seemed content to grapple with 2-horse work, at the maximum rate of 7 acres per day—at Canterbury it made light of 4-horse work at the rate of 11 acres, and executed that which was impracticable for horse-power at the maximum rate of 6 acres per day, drawing, if we may trust the dynamometer, at a much more rapid rate than horses could attain, three ploughs uphill and four down, with a furrow which it would require six horses to turn at their own pace.

But if these heavy soils had the worst of starting-points in this race of improvement, it must by no means be inferred that nothing has yet been done for them, or that blame is necessarily due where a good deal remains to be done. On such estates, farm-houses, homesteads, cottages, drains, fences, and roads, were all pretty much of a piece, and all required attention, so that the task of setting them to rights was the work of years, if not lives. If we look around, we may easily find farms to represent every stage of transition, from the status of the eighteenth century to that which now calls for the steam-plough to put the finishing stroke to its development.

The brick-kiln (itself the creature of railroad extensions and revised taxation) often lay at the root of this progress; that arterial drainage, which ought to have gone hand in hand with it, being too often baulked by untoward circumstances. With

a ready supply of tiles, the prejudice in favour of the bushes for the drains soon gave way, and tall broad fences disappeared. In the few cases in which tunnel tiles were made at home by machinery and delivered at their real cost price, many minor ditches were doomed.

As fuel became cheap, the pollards, with their inferior tops, their gnarled trunks, and intrusive roots, became a nuisance.

Where the elm was the *weed* of the soil it was rated accordingly; even as timber, great judgment being required in its seasoning and use to render it otherwise than dear at a gift, in competition with the home-grown larch, or lightly-taxed foreign timber.

Science of late has given her aid, and shown how small a portion of the rain-fall is carried away through the outfalls, even of a well-drained field,* and consequently how large a portion passes off by evaporation; and she also teaches us how much that evaporation is under our control, and dependent upon the admission of a free circulation of air, and therefore on the removal of small enclosures and high fences. On many grounds, therefore, the enterprising tenant has already even ventured his own money in enlarging his fields and improving their shape, thus becoming an unconscious ally of steam-culture.

One consideration, however, seems to stand in the way of these changes—viz., the trees—and that not so much for their value as timber, as for the part they play in our English scenery. The Englishman who has hailed the cheery landscapes of Kent, after a journey through "La Belle France," not by the railroad running in the valleys, but by the hill-climbing pavé, or who has opened his eyes in amazement to find that some western portions of the Emerald Isle show scarcely any feature but a succession of stone-barriers; such a man—unless he is an economist and nothing more—will hardly turn a deaf ear to an appeal on behalf of our trees.

But then there is a wide difference between an appreciation of the picturesque, and individual-tree-worship; and devotees of this class are not less at issue with the landscape-gardener, than they are with the agricultural reformer.

The landscape-gardener of the present day is as keenly bent on getting distance—vistas, at all hazards, as the tree-worshipper who has reluctantly called in his services, is bent on preserving from the axe as many of his favourites as possible. Conceptions of the beautiful are diverse and fluctuating. How almost antagonistic is English and French taste in this respect! where the

* *See* Mr. Bailey Denton's article on 'Hinxworth Drainage,' Royal Agricultura Society's Journal, vol. xx. p. 275, and tables.

one cries "How romantic! how beautiful!" the other exclaims "Ah, que c'est triste!" Happy is it then for steam-cultivation that the school of "breadth" and "distance" is in the ascendant. These are quite incompatible with small old-fashioned enclosures. They must give place; and thus the steam-plough will find an unexpected auxiliary in the landscape-gardener.

Moreover, the real lover of trees must be nearly as often pained as pleased when he looks at the stunted hedge-row timber, with wide-gaping wounds from the billhook of the hedger, who "primes them well up" every time he lays the quick, or from the ditcher's mattock, who polishes off the roots till they coincide with the face of his work. If the amateur woodman could only secure greater consequent attention to trees planted in parks and pastures, or to woods and plantations kept up in masses for the sake of sport or rural beauty, he, too, will hardly be an opponent of operations necessary to the introduction of the steam-plough.

If value be given to large regular supplies of water, and to this end that derived from the drainage be collected in ponds from tunnelled drains instead of open ditches, even the game-keeper, that "bête noir," will not grumble at the loss of a few fences which harboured game and vermin alike, and will rejoice in having more of green crops to drive the partridges into, and some power of marking which way they go; and he, too, will think well of steam.

With respect to roads, it is but a question of time and money. They are important in every point of view, and materials may always now be had, if not raised on the spot, delivered near at hand by the railroad, which in this, as in so many other respects, has done good service to agriculture.

In proof of this I may say that an estate of 5000 acres, which within my memory had hardly 100 yards of hard road within its border, has now metal conveyed to it along 10 miles of railroad with 8 more miles of carting; and yet, from the superiority of the materials, does not feel the charge excessive, whilst it looks forward to being supplied at a much shorter distance from a new station.

In the matter, then, of roads, as well as in other respects, the railroad has shown itself a most useful ally of steam-cultivation.

These hints are not so much drawn from fancy as from twenty years' experience of those Downing College estates which obtained unenviable notoriety for their broad, high fences, &c., in Mr. Jonas's Report on the Farming of Cambridgeshire (Journal, vol. vii. part i.) Their aspect is now much changed—it is hoped not for the worse,—but even yet they are not prepared to receive a Fowler, although a 7 or 8 horse engine might be successfully conveyed to most of the fields.

In conclusion, I have to thank Lord Hatherton, Mr. Hill, agent to the Duke of Manchester, Mr. Faux, and Mr. Pike, for information respecting Smith's Cultivator. The testimonials furnished to Mr. Fowler up to a recent date in part superseded private inquiry, either by furnishing an answer, or indicating that it could not be given ; I shall be glad, however, to receive from any owner of a steam-cultivator information and correction on a subject which is by no means exhausted, and beg, in conclusion, to call attention to three points of inquiry.

1st. The average cost of maintaining a locomotive engine at rough work in rather unskilful hands.

2ndly. The effects of working at a pressure above 60 lbs. on the square inch on the wear and tear of the engine, the power generated, and the fuel consumed.

3rdly. The influence of working at different velocities on the force required to perform a given quantity of work.

Cambridge.

Dumbleton Hall, Evesham, Dec. 31, 1860.

My dear Sir,—Although this is my third season of ploughing by steam-power, yet from my having commenced with an imperfect (10-horse) engine, a 3-furrow plough, and old anchor and ropes, my experience will not allow of my replying satisfactorily to your queries, which have reference rather to what *can be now done* with the more perfect machinery and tackle supplied by Mr. Fowler, than to what could be accomplished under the above circumstances.

It was only at Michaelmas last that I started one of Fowler's improved (12-horse) engines; and it was not until the middle of October that I was able to avail myself of his recent alterations in the disposition of ropes and tackle, of his new and less complicated anchor, and of his improved 4-furrow plough.

I have stated that I have been using a steam-plough for three seasons, but that up to Michaelmas last I worked with defective machinery. Up to that time I had steam-ploughed (in all, from the period of my commencing) 500 acres. My expenses were as follows:—

	£.	s.	d.
Mr. Fowler's bill	751	19	6
Railway expenses (carriage)	26	19	4
	£778	18	10

My repairs during these two seasons, whilst making use of old machinery, amounted to 93*l.* 7*s.* 2*d.* This cannot, however, be considered as a basis on which to calculate wear, tear, and depreciation connected with *improved* steam-ploughing machinery.

I will therefore state what I have done since discarding my defective machinery at Michaelmas last, at which date, to the cost

of plant already given, must be added the sum paid to Mr. Fowler on exchanging my old for improved plant:—

	£.	s.	d.
Expended up to Michaelmas last	778	18	10
Additional sum paid to Mr. Fowler on exchanging old for new plant at Michaelmas last	40	19	6
	£819	18	4

Since Michaelmas I have steam-ploughed about 140 acres in 31 days (and many of these have been short winter days), under the influence of a bad season, and much of it being land lying on the side of a hill of considerable inclination. Notwithstanding these drawbacks, the average day's ploughing, accomplished according to this statement, amounts to something above $4\frac{1}{2}$ acres; and I think that, with Fowler's improvements, I am justified in stating that (including removals from field to field) I can plough on an average 5 acres of stiff land in a day; at a depth of from 4 to 6 inches for a corn crop, and from 8 to 10 inches for roots; or if, instead of ploughing, we are using a steam cultivator (or scuffler), our average day's work may be put at 10 acres a-day, at a depth of from 8 to 10 inches. The total area of my arable land is under 400 acres; the amount of steam cultivation that can be beneficially applied to it may be thus (approximately) stated:—

	Acres.		Days.
For wheat (one ploughing)	100	..	20
For roots (ditto) in the autumn	100	..	20
Spring cultivation land (scuffled twice) ..	100	..	20
Extra work (foul land scuffled once)	100	..	10
For barley (one ploughing)	100	..	20
	500	..	90

In thus estimating the work done by the steam plough in the course of the year upon land in my own occupation, I have thought it best to base the calculation on some system: I have therefore taken the four-course system as my basis, that being the one more generally understood; still I ought to state that, as I by no means confine myself to four courses, the amount of ploughing and that of cultivation (scuffling) must vary with the seasons.

The expenses of a day's work at steam-ploughing are as follows:—

		£.	s.	d.
The engine-man	3*s.*	0	11	9
Ploughman	2*s.* 6*d.*			
Two men, at 2*s.* 2*d.* each	4*s.* 4*d.*			
Boy with water-cart	1*s.*			
Extra labour	11*d.*			
A horse with the water-cart		0	3	0
Half a ton of coal		0	7	0
Oil		0	1	0
Total		£1	2	9

You lately suggested that a charge of 1*l.* 10*s.* per day would probably be sufficient to cover the cost of interest, repairs, and depreciation of machinery and tackle. I am willing to adopt this estimate, which, when added to the day's expenses (1*l.* 2*s.* 9*d.*), gives as the total cost of ploughing 5 acres 2*l.* 12*s.* 9*d.*, being a charge of (say) 10*s.* 6*d.* an acre for steam-ploughing; and since we can in a day cultivate (scuffle) double the quantity ploughed, the cost of cultivating may be considered as one-half, or 5*s.* 3*d.* an acre.

About here in ordinary ploughing four horses are used in a team. They get over on an average three-quarters of an acre in a day, and it is reckoned that the cost of ploughing an acre may be put at 20*s.* According to my showing, the cost therefore of *steam*-ploughing is 10*s.* 6*d.* an acre, against *horse*-ploughing at 20*s.* It should be remembered, however, that when the plough and tackle are not at work the engine is useful in other departments of the farm; I ought not therefore properly to charge the ploughing, as I have done, with the whole cost of the interest and wear and tear of the engine.

The advantage of employing steam-power on heavy land is not confined to a reduced expenditure in cultivation, and to increasing the depth of tillage, but by accomplishing so large a daily acreage you are less liable (than in the slower process of ordinary ploughing) to stoppages in consequence of changes in the weather; and by keeping off your land the heavy treading of horses, that consolidation is avoided which is so injurious to crops on our stiff clays. Then, again, the diminution in the number of horses stabled is a great source of economy. Mr. Morton calculates that a working horse cannot be kept at a less cost than 30*l.* a-year; and this agrees with my experience altogether. When I commenced steam-ploughing I had in my stable twenty working horses: I have now ten: that is, my stable expenditure is reduced by one-half. Wishing that I were able to reply more fully to your queries,

I remain, my dear Sir, yours very truly,

ED. HOLLAND.

P. H. Frere, Esq.

XXIII.—*On the Composition of Oxen, Sheep, and Pigs, and of their Increase whilst Fattening.* By J. B. LAWES, Esq., F.R.S., F.C.S., and DR. J. H. GILBERT, F.R.S., F.C.S.

MORE than ten years ago we commenced a series of articles in this Journal, the expressed object of which was to elucidate the chemistry of the feeding of animals, considered as a process for the manufacture of *meat* and *manure*—and, as such, constituting a highly important branch of the business of the farmer. It was proposed to investigate experimentally—

1. The amount of food, or of its several constituents, consumed —*in relation to a given weight of animal within a given time.*

2. The amount of food, or of its several constituents, consumed —*to produce a given amount of increase in live-weight.*

3. The proportion, and relative development, of the different *organs*, or *parts*, of fattening animals;—their *chemical composition*;—and the probable composition of their *increase* during the feeding process.

4. The composition of the *solid* and *liquid excrements*—that is, the *manure*—in relation to that of the food consumed.

5. The loss or expenditure of constituents, by respiration and by the cutaneous exhalations—that is, in the mere sustenance of the living meat and manure making machine.

The discussion of the fourth and fifth branches of the inquiry here enumerated, must still be postponed to some future opportunity.

The third branch—namely, that relating to the composition of the *animals* themselves, and of their *increase* whilst fattening—constitutes the special subject of the present paper.

Before entering upon the consideration of these questions we shall give, by way of introduction, a brief summary of the facts and conclusions bearing upon the first two, or preliminary points of the main inquiry.

I. On the Amounts of Nitrogenous Compounds, of Non-Nitrogenous Compounds, and of Total Dry Substance, consumed—in relation to a given weight of animal within a given time—and to produce a given amount of Increase.

To acquire the necessary data relating to this branch of the subject, some hundreds of animals—oxen, sheep, and pigs—were supplied for many weeks or months consecutively, with given quantities of food, of known composition; and the weights of the animals themselves were also taken, both at the beginning and at the end of the experiments. For full particulars of the results, the reader is referred to our detailed Reports, published partly in this Journal,* and partly elsewhere.†

Table I. (p. 436) gives a summary of the results relating to Sheep, and Table II. (p. 437) of those relating to Pigs.

In these Tables the organic substance of the food is only subdivided into the two main classes of—1st, Total nitrogenous substance; and 2nd, Total non-nitrogenous substance. It is obvious that this is a very imperfect classification of the constituents of food.

* Journal of the Royal Agricultural Society of England, vol. x., part i.; vol. xii., part ii.; vol. xiii., part i.; vol. xiv., part ii.; and vol. xvi., part i.

† Report of the British Association for the Advancement of Science, for 1852, and for 1854.

The so-called *nitrogenous* substance, calculated from the amount of nitrogen the food contains, must obviously be of very different character, according to the description of the food. In ripened products it will probably be available for the purposes of the system in larger proportion than in unripened or succulent ones. In unripened vegetable products a considerable portion of the nitrogen often exists in a condition in which, if not injurious, it is, to say the least, certainly not assimilable. Even in ripened ones it may exist in very different degrees of digestibility and assimilability.

Again, the so-called "*non*-nitrogenous substance" may include cellulose (or "woody-fibre"), starch, sugar, or gum—all of which have a very similar chemical composition; also various bodies of the pectine class; and fatty matter.

Recent investigations have demonstrated that a considerable proportion of the more delicate *cellulose* of our current food-stuffs, may be digested; and so far as it is so, its value as a constituent of food will probably range pretty closely with that of sugar and of starch. But, a large proportion of the woody-fibre, included under our term *non*-nitrogenous substance, is passed by the animal entirely undigested.

So far as can be judged, the *pectine* compounds have, weight for weight, a somewhat less feeding value than either starch or sugar.

Lastly, for practical purposes, a given amount of *fatty matter* in food, may be considered as equivalent to about 2½ times its weight of starch, or sugar.

From the above considerations it will be obvious that, in reading the actual figures given in the Tables, regard must be had to the known character (according to the description of the foods employed) of the substances classed respectively as "nitrogenous," and "non-nitrogenous." In our fuller Reports, already referred to, we have called attention to this point; and so far as the experiments with pigs are concerned, the food of which contains comparatively little indigestible woody-fibre, we have so far distinguished between the different *non*-nitrogenous constituents, as to give the *fatty matter*, and the non-nitrogenous substance *not* fat, separately.

With these explanatory observations we proceed, very briefly, to call attention to the more general conclusions to be drawn from the results.

It is seen that, in all cases comparable on the point, there is much more of uniformity of amount within the columns of *non*-nitrogenous substance, and *total dry substance*, than in those of the *nitrogenous* substance. This is the case both in regard to the quantities consumed—*to a given weight of animal within a given time*, and to those consumed—*to produce a given amount of increase in live-weight*. The deviations from the general regularity in the

amounts

Table I.—Amounts of Nitrogenous Compounds, Non-Nitrogenous Compounds, and Total Dry Substance, consumed—(1) per 100 lbs. live-weight, per week; (2) to produce 100 lbs. gross Increase.

Sheep.

Pen Nos.	Description of Food. Given in Limited Quantity.	Description of Food. Given ad libitum.	Consumed per 100 lbs. live-weight, per week. Nitrogenous Substance.	Consumed per 100 lbs. live-weight, per week. Non-nitrogenous Substance.	Consumed per 100 lbs. live-weight, per week. Total Dry Substance (including Mineral Matter).	Consumed to produce 100 lbs. gross Increase. Nitrogenous Substance.	Consumed to produce 100 lbs. gross Increase. Non-nitrogenous Substance.	Consumed to produce 100 lbs. gross Increase. Total Dry Substance (including Mineral Matter).	Non-Nitrogenous Substance to 1 Nitrogenous Substance in Food.
	Series 1.—5 Sheep in each pen, 14 weeks.								
1	Oil-cake	Swedish turnips.	2·53	9·80	13·05	170	657	876	3·86
2	Oats	Swedish turnips.	1·69	11·29	13·66	103	691	863	6·70
3	Clover chaff	Swedish turnips.	1·80	12·98	15·75	103	744	902	7·22
4	Oat-straw chaff	Swedish turnips.	1·13	10·14	11·90	103	923	1083	8·96
	Means		1·79	11·05	13·59	120	754	931	6·28
	Series 2.—5 Sheep in each pen, 19 weeks.								
1	Oilcake	Clover chaff.	3·77	12·96	18·18	321	1103	1548	3·44
2	Linseed	Clover chaff.	3·21	12·69	17·19	289	1144	1550	3·96
3	Barley	Clover chaff.	2·56	13·83	17·64	235	1269	1619	5·40
4	Malt	Clover chaff.	2·56	14·01	17·82	266	1458	1854	5·48
	Means		3·02	13·37	17·71	278	1243	1643	4·47
	Series 3.—5 Sheep in each pen, 10 weeks (no limited foods).								
1	Norfolk white turnips; mineral manures only		1·20	10·20	12·22	191	1628	1950	8·52
2	Norfolk white turnips; mineral manures, and ammoniacal salts		1·52	9·24	11·59	153	930	1170	6·08
3	Norfolk white turnips; mineral manures, and rape cake		1·69	8·80	11·43	324	1682	2186	5·19
4	Norfolk white turnips; mineral manures, rape cake, and ammoniacal salts		2·14	7·60	10·68	Lost weight.	Lost weight.	,,	3·55
	Means		1·64	8·96	11·48	223	1413	1769	5·46
	Series 4.—5 Sheep in each pen, 10 weeks.								
1	Barley (ground)	Mangolds	1·71	10·59	13·11	118	732	905	6·20
2	Malt (ground) and malt-dust	Mangolds	1·65	10·08	12·50	111	677	840	6·10
3	Barley (ground and steeped)	Mangolds	2·09	12·61	15·73	121	730	909	6·03
4	Malt and Malt-dust steeped	Mangolds	1·77	10·70	13·31	136	822	1022	6·04
5	Malt and Malt-dust (extra quantity)	Mangolds	1·90	11·63	14·42	127	776	961	6·11
	Means		1·82	11·12	13·81	123	748	927	6·08
	Series 5.—Different Breeds of Sheep.								
46 Cotswolds—20 Weeks	Oilcake and clover chaff	Swedish turnips.	3·52	12·40	17·07	166	582	802	3·51
40 Leicesters—20 Weeks	Oilcake and clover chaff	Swedish turnips.	3·37	11·16	15·68	187	619	870	3·31
40 Cross-bred Wethers—20 Weeks	Oilcake and clover chaff	Swedish turnips.	3·53	11·69	16·43	186	616	866	3·31
40 Cross-bred Ewes—20 Weeks	Oilcake and clover chaff	Swedish turnips.	3·48	11·51	16·21	185	610	858	3·30
40 Hants Downs—26 Weeks	Oilcake and clover chaff	Swedish turnips.	3·38	11·07	15·63	187	613	866	3·28
40 Sussex Downs—26 Weeks	Oilcake and clover chaff	Swedish turnips.	3·37	10·99	15·55	190	620	877	3·26
	Means		3·44	11·47	16·09	183	610	856	3·33

TABLE II.—Amounts of Nitrogenous Compounds, of Non-nitrogenous Compounds, and of Total Dry Substance, consumed—(1) per 100 lbs. live-weight, per week; (2) to produce 100 lbs. gross Increase.

PIGS.

Pen Nos.	DESCRIPTION OF FOOD. Given in Limited Quantity.	DESCRIPTION OF FOOD. Given ad libitum.	Consumed per 100 lbs. live-weight, per week. Nitrogenous Substance.	Consumed per 100 lbs. live-weight, per week. Non-nitrogenous Organic Substance.	Consumed per 100 lbs. live-weight, per week. Total Dry Substance (including Mineral Matter).	Consumed to produce 100 lbs. gross Increase. Nitrogenous Substance.	Consumed to produce 100 lbs. gross Increase. Non-nitrogenous Organic Substance.	Consumed to produce 100 lbs. gross Increase. Total Dry Substance (including Mineral Matter).	Non-Nitrogenous Substance to 1 Nitrogenous Substance in Food.
	SERIES 1.—3 Pigs in each pen, 8 weeks.								
1	None	Bean and lentil meal	8·84	17·6	28·0	138	275	437	1·99
2	Indian-meal	Bean and lentil meal	8·13	19·8	29·3	114	278	412	2·43
3	Bran	Bean and lentil meal	7·71	17·8	27·1	161	372	566	2·31
4	Indian-meal and bran	Bean and lentil meal	6·87	20·0	28·2	121	351	496	2·91
5	None	Indian-meal	2·91	19·3	22·5	57	378	452	6·61
6	Bean and lentil meal	Indian-meal	4·55	21·1	26·3	73	337	420	4·65
7	Bran	Indian-meal	3·95	22·5	27·1	58	332	401	5·69
8	Bean and lentil meal and bran	Indian-meal	5·20	22·1	28·3	73	309	395	4·26
9	Bean and lentil meal	Bran	5·19	13·7	20·1	198	523	770	2·64
10	Indian-meal	Bran	3·90	18·7	23·7	130	620	785	4·77
11	Bean and lentil meal, and Indian-meal	Bran	4·96	17·0	23·4	114	391	540	3·43
12	Bean and lentil meal, Indian-meal, bran, each ad libitum		6·12	20·1	27·2	107	350	474	3·28
	Means		5·69	19·1	25·9	112	376	511	3·36
	SERIES 2.—3 Pigs in each pen, 8 weeks.								
1	None	Bean and lentil meal	6·69	14·5	22·2	146	317	484	2·17
2	3 lbs. barley-meal	Bean and lentil meal	8·29	22·6	32·1	137	374	533	2·72
3	1 lb. bran	Bean and lentil meal	8·73	20·0	30·2	152	348	525	2·29
4	3 lbs. barley-meal, 1 lb. bran	Bean and lentil meal	6·80	20·6	28·6	125	378	525	3·04
5	None	Barley-meal	3·91	23·6	28·3	64	385	461	6·02
6	1½ lb. bean, and 1½ lb. lentil meal	Barley-meal	5·17	20·0	26·0	91	352	459	3·87
7	1 lb. bran	Barley-meal	4·06	23·2	28·2	66	378	460	5·71
8	1½ lb. bean, 1½ lb. lentil meal, and 1 lb. bran	Barley-meal	4·64	17·2	22·7	100	372	491	3·71
9	Mixture of 1 part bran, 2 parts barley-meal, and 3 parts bean and lentil meal, ad lib.		6·65	20·6	28·4	117	362	501	3·10
10	Duplicate of pen 9		7·03	21·9	30·3	110	342	473	
11	Mixture of 1 part bran, 2 parts bean and lentil meal, and 3 parts barley-meal, ad lib.		5·86	21·4	28·4	88	320	425	3·66
12	Duplicate of pen 11		6·02	22·1	29·4	87	321	425	
	Means		6·15	20·6	27·9	107	354	480	3·32
	SERIES 3.—4 Pigs in each pen, 8 weeks.								
1	Dried cod-fish	Bran and Indian-meal (equal parts)	5·30	16·6	23·7	104	326	464	3·13
2	Ditto	Indian-meal	4·36	16·6	22·1	75	287	382	3·80
3	Dried cod-fish—bran and Indian-meal (equal parts)—each ad lib.		5·71	19·5	27·0	108	368	511	3·41
4	Dried cod-fish	Mixture of 2 parts barley-meal, and 1 part bran	5·95	21·0	28·9	98	316	476	3·53
5	Ditto	Barley-meal	5·76	25·7	33·0	80	357	458	4·47
	Means		5·42	19·9	27·0	93	337	458	3·62
	SERIES 4.—3 Pigs in each pen, 10 weeks.								
1	Lentils and bran	Sugar	4·89	19·9	25·8	81	330	427	4·07
2	Ditto	Starch	4·90	20·0	25·7	81	329	425	4·07
3	Ditto	Sugar and starch	4·85	22·9	28·6	74	351	439	4·71
4	Lentils, bran, sugar, and starch, each ad lib.		5·70	22·4	29·0	82	320	417	3·90
	Means		5·09	21·3	27·3	79	332	427	4·18

amounts are, however, much less than the actual figures show, when due allowance is made, both for those of the non-nitrogenous constituents of the food which would probably be indigestible and pass through the animal unchanged, and also for the different respiratory and fat-forming *capacities* of the portions which are digestible and available for the purposes of the animal economy.

It must further be remembered that, even if all due allowance, such as is here supposed, were made, the amounts must still cover all variations—whether arising from differences in the external conditions of the experiments, from individual peculiarities in the animals themselves, from the different amounts stored up according to the suitableness of the foods, as well as from the many other uncontrollable circumstances which must always interfere with any attempts to bring within the range of accurate numerical measurement, the results of those processes in which the subtle principle of animal life exerts its influence.

On the other hand, with a general uniformity in the amounts of *available non*-nitrogenous constituents consumed (by a given weight of animal within a given time, and to produce a given amount of increase), those of the *nitrogenous* constituents are found to vary, under the same circumstances, in the proportion of from 1 to 2 or 3. Nor (excepting in a few cases) can this great variation be attributed to difference in the condition of the nitrogenous substances in regard to digestibility and assimilability.

The pig requires much less of mere *bulk* in his food than either the ox or the sheep. Whilst the fattening food of the latter animals is principally composed of grass, or hay or straw, and roots, with a comparatively small proportion of cake or corn, that of the pig comprises a larger proportion of corn, and its dry substance consists, weight for weight, of a much larger proportion of digestible or convertible constituents (starch, sugar, &c., and highly-elaborated nitrogenous compounds), and contains much less of effete woody-fibre, than does that of oxen and sheep.

Notwithstanding the generally richer character of his food, the fattening pig is found to consume a much larger quantity of dry substance in relation to his weight than the sheep. He at the same time yields a larger amount of *increase* in proportion to the dry substance of the food consumed.

For practical purposes it may be assumed, that sheep, when fed liberally upon good fattening food composed of a moderate proportion of cake or corn, a little hay or straw chaff, together with roots or other succulent food, will yield, over a considerable period of time, 1 part of increase in live-weight for from 8 to 10 parts of the *dry substance* of such mixed food. The

quantity of dry substance of food required will vary between these limits, according to the exact description and quality of the food, and other circumstances. But 9 parts of dry substance of food for 1 of increase in live-weight may be taken as a very fair average result for sheep, with good food, and good management.

In the case of liberally-fed pigs, 1 part of increase in live-weight should be obtained from 4 to 5 parts of the dry substance of the fattening food.

In reference to the point just referred to, it may be considered that oil-cakes and foreign corn will, on the average, contain rather more than six-sevenths, and home-grown corn, hay, &c., rather less than six-sevenths, of their weight of "dry substance." In the same way, it may be reckoned that the commoner sorts of turnips will, on the average, contain about one-twelfth, swedes about one-ninth, mangolds about one-eighth, and potatoes about one-fourth, of their weight of "dry substance."

Sheep (and oxen also), fattening on food of recognised good quality, may give a maximum amount of increase for a given amount of dry substance of food, although the latter contain as much as 5 or even 6 parts of *non*-nitrogenous substance to 1 of *nitrogenous* compounds. The latter proportion is about that in which the two classes of constituents exist in the dry substance of the cereal grains; but in these the proportion of the non-nitrogenous substance which will be indigestible woody-fibre, will be less than in the mixed diet of sheep and oxen. Hence, supposing the relation of the total *non*-nitrogenous to the nitrogenous substance to be the same in the two cases, the proportion of the really digestible non-nitrogenous substance will be somewhat less in the mixed diet of these animals so fattening, than in the average of cereal grains.

When pigs are fattened almost exclusively on corn, they do not appear to require more than 1 part of nitrogenous to about 5 or 6 parts gross non-nitrogenous substance, to yield the maximum amount of increase in proportion to the dry substance of food consumed. But, since there is a less proportion of indigestible woody-fibre in their food than in that of sheep and oxen, it would appear that they can give a maximum amount of increase, with even a somewhat smaller proportion of the nitrogenous to the *digestible non*-nitrogenous constituents, in their fattening food.

The above proportions are those upon which the respective animals will frequently attain the greatest rate of increase during the later stages of feeding. With these the increase will, however, probably be very fat. In the earlier stages of growth and feeding, a somewhat higher relation of nitrogenous constituents is desirable, if not even essential, for the best progress of the animal.

It should here be particularly observed, that taking into consideration the cost of many of the foods which are high, compared with that of those which are low in their percentage of nitrogenous substance, and also the higher value of the *manure* from those which are rich in nitrogen, it is almost invariably the most profitable for the farmer to employ stock-foods containing a larger proportion of nitrogenous constituents—even up to the end of the feeding process—than is essential for the maximum rate of increase.

From a view of the whole of the evidence bearing upon this branch of the subject, it may be concluded, that when stock-foods contain a certain amount of nitrogenous substance below which few of our current fattening food-stuffs are found to go, it is their supply of available *non*-nitrogenous, rather than that of their nitrogenous constituents, which rules both *the amount of the food consumed*, and *the increase in live-weight produced.*

When it is considered how large is the share of influence which the demands of the respiratory process must have upon the amount of food consumed, it can hardly excite surprise that, at least *consumption*, should be chiefly regulated by the supply of compounds rich in *carbon* and *hydrogen*, rather than nitrogen.

That the amount of *increase* should also bear a closer relationship to the amount of the *non*-nitrogenous than to that of the *nitrogenous* constituents of food, will doubtless appear to be inconsistent with the generally-adopted notion of the highly nitrogenous character of animal bodies, and especially with the also frequently implied assumption that in the current food-stuffs the proportion of nitrogenous substance is likely to be often insufficient to supply the amount required for the production, or restoration, of the nitrogenous compounds of the animal organism.

The questions here arise—what is the composition of the animals the farmer feeds?—what the composition of their increase whilst fattening?—and what the relation of this to that of the food consumed?

II. On the Proportion, and Relative Development, of the different Organs and Parts, of Fattening Oxen, Sheep, and Pigs.

Before discussing the *chemical* composition of the animal bodies, and of their increase, it will be well to consider the proportion which the various organs (or other more arbitrarily separated parts) bear to the entire body, in the different descriptions of animal, and also the proportion, and tendency of development, according to the condition of growth or fatness. In fact, it is the judgment of the character of the slaughtered animals in these

respects which determines, in the view of the practised eye, the quality and value of the meat that the feeder has produced.

To obtain the experimental data relating to this branch of the subject, 2 calves, 2 heifers, and 14 bullocks, 1 lamb and 249 sheep, and 59 pigs, have been operated upon. The plan adopted was, to determine the *live-weight* just before slaughtering; and, as soon as possible afterwards (so as to lessen the error arising from evaporation) to determine the weight of the *carcass*, of *each of the internal organs*, and of some other separated parts.

The animals are classified according to description, breed, condition of maturity, or kind of food; and, in the Tables which follow (III.-IX. inclusive, pp. 443 to 449), the *average* results only (both actual and percentage), are given.

For further details the reader is referred to the 'Philosophical Transactions of the Royal Society,' Part II., 1859, where both the actual weights, and the percentage proportion, of the separated organs and parts, of each of the 327 slaughtered animals, are recorded.

A few words may first be offered directing attention to the more prominent points of distinction between the different descriptions of animal—oxen, sheep, and pigs—in regard to the amount, and the proportion in the whole body, of their respective organs and parts. These are illustrated by the average results, recorded side by side, in Table III., respectively of 16 heifers and bullocks, of 249 sheep, and of 59 pigs.

The proportion of the stomachs and their contents constituted in the oxen about $11\frac{1}{2}$, in the sheep about $7\frac{1}{2}$, and in the pig only about $1\frac{1}{4}$ per cent. of the entire weight of the body. The proportions of the intestines and their contents stand in the opposite relation. Thus, they amounted to about $6\frac{1}{4}$ per cent. in the pig, to about $3\frac{1}{2}$ per cent. in the sheep, and to only about $2\frac{3}{4}$ per cent. in the oxen.

These distinctions are of considerable interest, and are perfectly intelligible when taken in connection with the fact that in the food of oxen and sheep there is so large a proportion of indigestible woody-fibre, and in that of the well-fed pig so much less, and at the same time a comparatively large proportion of *starch*—the primary transformations of which are supposed to take place chiefly after leaving the stomach, and more or less throughout the intestinal canal.

Taking together stomachs, small intestines, large intestines, and their respective contents, the entire bodies of the oxen yielded an average of rather more than 14 per cent., of the sheep a little more than 11 per cent., and of the pigs about $7\frac{1}{2}$ per cent. With this great variation in the proportion of the receptacles and first

laboratories of the food, with their contents, the further elaborating organs (if we may so call them) with their fluids, appear to be much more equal in their proportion in the three cases.

This point is approximately illustrated in the fact that, taking together the recorded percentages of "heart and aorta," "lungs and windpipe," "liver," "gall-bladder and contents," "pancreas," "milt or spleen," and the "blood," the sum is for the oxen about 7 per cent., for the sheep about $7\frac{1}{4}$ per cent., and for the pigs about $6\frac{2}{3}$ per cent. If from this list we exclude the *blood*, which was more than one-third of a per-cent. lower in the pig than in the other animals, the sums of the percentages of the other parts enumerated, would agree still more closely for the three descriptions of animal.

Lastly, in regard to the distinctions between the different descriptions of animal: of the masses of internal "loose fat," with its connecting membrane, the oxen yielded on the average about $4\frac{1}{2}$ per cent., the sheep about $7\frac{3}{4}$ per cent., and the pig little more than $1\frac{1}{2}$ per cent. The pig, therefore, with its much less proportion of alimentary organs, has also a much less proportion of the fat which surrounds them. With regard to the much larger amount of this sort of fat indicated in the sheep than in the oxen, it may be remarked that a considerable proportion of the sheep which contribute to these recorded averages were, compared with the oxen, in more than a corresponding degree of maturity and fatness.

A rapid survey may next be taken of the relative development of the several organs and parts, as the animal progresses in maturity and fatness.

An examination of the Tables (IV.-IX.) shows that the internal organs and other "offal" parts pretty generally *increase* in *actual weight* as the animal passes from the store or lean, to the fat or to the very fat, condition; but that, excluding the loose fat—which increases not only in actual weight but proportionally—their *percentage proportion* in the whole body as invariably *diminishes* as the animal matures and fattens.

The *carcasses*, on the other hand, invariably increase both in *actual* and in *percentage* amount, as the animals mature.

The above remarks apply generally to oxen, sheep, and pigs; but the data relating to the sheep comprise the most complete gradationary series for their illustration.

Thus, the average *actual* weights per head of the collective stomachs and intestines, and their contents, *increased* from about $13\frac{3}{4}$ lbs. in 5 *store* or *lean* sheep, to about $15\frac{3}{4}$ lbs. in 100 *fat* sheep, and to about $16\frac{1}{4}$ lbs. among 45 *very fat* ones. Again, the heart and aorta, the lungs and windpipe, the liver, the gall-bladder and contents, the pancreas (sweetbread), the milt or spleen, and the blood,

TABLE III.

Summary.—Mean *Actual* Weights (lbs. and ozs.), and Mean *Percentage* Proportion in the entire Bodies, of the different Organs and Parts of different Descriptions of Animal.

OXEN, SHEEP, AND PIGS.

DESCRIPTION OF PARTS.	Mean Actual Weights (lbs. and ozs.)						Mean Percentage Proportions in the Fasted Live-Weights.		
	Means of 16 Heifers and Bullocks.		Means of 249 Sheep of different Breeds, conditions of Fatness, Age, &c.		Means of 59 Pigs.		Means of 16 Heifers and Bullocks.	Means of 249 Sheep of different Breeds, conditions of Fatness, Age, &c.	Means of 59 Pigs.
	lbs.	ozs.	lbs.	ozs.	lbs.	ozs.			
Separate parts of the "Offal."									
Stomachs	35	13·9	3	12·3	2	10·4	3·17	2·45	1·28
Contents of stomachs (and vomit)	92	12·8	7	10·4			8·34	4·98	
Caul fat	23	2.9	7	1·8	1	2·3	2·02	4·63	0·54
Small intestines and contents	17	12·0	2	7·6	4	8·4	1·60	1·61	2·20
Large intestines and contents	13	7·0	2	15·2	8	5·7	1·24	1·92	4·04
Intestinal fat	26	5·4	3	2·2	2	5·6	2·24	2·04	1·06
Heart and aorta	5	10·6	0	10·4	0	9·6	0·50	0·43	0·29
Heart fat	3	3·8	0	7·8	..		0·31	0·32	..
Lungs and windpipe ..	9	3·6	1	8·3	1	9·1	0·81	0·99	0·76
Blood	45	12·8	6	1·6	7	10·1	4·01	3·97	3·63
Liver	14	13·3	2	5·4	3	4·5	1·31	1·52	1·57
Gall-bladder and contents	0	15·7	0	1·5	0	2·1	0·09	0·06	0·06
Pancreas ("sweetbread")	1	1·0	0	3·3	0	6·6	0·09	0·14	0·19
Thymus-gland ("heart-bread")	0	10·7	..		..		0·06	..	..
Glands about the throat ("throatbread") ..	0	5·5	..		..		0·03	..	..
Milt or spleen	1	13·9	0	4·0	0	4·7	0·16	0·16	0·14
Bladder	0	9·1	0	0·8	0	2·5	0·05	0.03	0·03
Penis	..		..		0	7·1	..	..	0·21
Brains	0	12·0	..		*		0·06	..	*
Tongue	30	10·7	4	8·1	1	0·2	2·69	2·93	0·48
Head					*				*
Hide, or skin and wool	84	9·5	18	0·4	..		7·49	11·73	..
Feet and hoofs	20	0·6	..		0	2·9†	1·77	..	0·08†
Tail	1	1·9	..		*		0·10	..	*
Diaphragm ("skirts")	5	2·0	0	3·4	..		0·41	0·14	..
Miscellaneous trimmings	3	15·3	0	3·0	0	8·8	0·30	0·12	0·26
Total "Offal" parts	439	14·0	61	11·5	35	4·6*	38·85	40·17	16·87*
Carcass	680	12·0	91	12·5	176	5·3*	59·31	59·74	82·57*
Loss by evaporation, error in weighing, &c.	20	7·1‡	0	2·2	1	2·1	1·84	0·09	0·56
Live-weight after fasting ..	1141	1·1	153	10·2	212	12	100·00	100·00	100·00

* In the case of the Pigs, the head (with brains), feet, and tail, are included with carcass, and not with the offal, as in the other animals.

† These quantities relate to the toes only.

‡ Penis or womb included here

Table IV.

Mean Actual Weights (lbs. and ozs.) of the different Organs and Parts of—

Calves, Heifers, and Bullocks.

Description of Parts.	Means of 2 Fat Calves.		2 Fat Heifers.		14 Fat Bullocks.		2 Heifers and 14 Bullocks.	
	lbs.	ozs.	lbs.	ozs.	lbs.	ozs.	lbs.	ozs.
Separate parts of the "Offal."								
Stomachs	3	6·5	32	0	36	6·7	35	13·9
Contents of stomachs	4	12·1	70	12	95	15·2	92	12·8
Caul fat	2	9·2	23	4	23	2·7	23	2·9
Small intestines and contents	5	5·5	15	4	18	1·7	17	12·0
Large intestines and contents	3	4	12	2	13	10·0	13	7·0
Intestinal fat	2	14	26	3	26	5·8	26	5·4
Heart and aorta	1	7·7	4	0	5	14·4	5	10·6
Heart fat	0	3·5	1	14	3	6·9	3	3·8
Lungs and windpipe	3	4·8	6	6·5	9	10·1	9	3.6
Blood	11	12·5	30	12	47	15·2	45	12·8
Liver	4	2·8	12	15	15	1·6	14	13·3
Gall-bladder and contents	0	2	0	10·8	1	0·5	0	15·7
Pancreas ("sweetbread")			0	13	1	1·6	1	1
Thymus gland ("heartbread") ..	1	11	0	9·2	0	11	0	10·7
Glands about the throat ("throat-bread")			0	5·7	0	5·5	0	5·5
Milt or spleen	0	13	1	4	1	15·3	1	13·9
Bladder	0	6	0	8	0	9·2	0	9·1
Penis			..		0	7·5	..	
Brains					0	12·1	0	12
Tongue	13	9·5	21	7	32	0.5	30	10·7
Head								
Hide	17	6·2	65	14	87	4·3	84	9·5
Feet and hoofs	5	7·5	14	10	20	13	20	0·6
Tail	0	5·2	0	12·8	1	1·3	1	1·9
Diaphragm ("skirts")	1	1·5	4	9·5	5	3·2	5	2
Miscellaneous trimmings	..		4	6	3	14·3	3	15·3
Total "Offal" parts	84	0·5	351	6·5	452	13·6	439	14·0
Carcass	158	3·5	474	10	710	3·1	680	12
Loss by evaporation, error in weighing, &c.	8	8·0	27	13·5*	19	0·8	20	7·1
Live-weight after fasting	250	12	853	14	1182	1·5	1141	1·1

* This amount includes the wombs of the Heifers, one of which was with Calf.

Table V.

Mean Actual Weights (lbs. and ozs.) of the different Organs and Parts of—

Sheep.

DESCRIPTION OF PARTS.	Means of											
	Gradationary Series.						Miscellaneous.					
	5 Sheep of different Breeds, killed in Store condition, for a standard of comparison.		100 Sheep of different Breeds, moderately Fattened. About 1¼ Year old.		45 Sheep of different Breeds, excessively Fattened. About 1¼ Year old.		78 Hants Down Sheep, moderately Fattened, on different Foods. 1¼ to 1½ Year old.		21 Sheep of various Breeds and Modes of Feeding, of more than Average Fatness. About 1¼ Year old.		249 Sheep of different Breeds, conditions of Fatness, Age, &c.	
	lbs.	ozs.	lbs.	ozs.	lbs.	ozs.	lbs.	ozs.	lbs.	ozs.	lbs.	ozs.
Original weight	..		102	7	99	1·8	124	7·2	..		107	7·2
Final weight, unfasted	99	0	156	0·8	202	7·5	148	9·1	179	15·2	162	15·4
Fasted live-weight ..	93	0·8	145	5·3	192	0·3	141	6·7	170	12·2	153	10·2
Separate parts of the "Offal."												
Stomachs	2	11·5	3	9·8	4	1·9	3	13·5	3	11·2	3	12·3
Contents of stomachs	6	2·5	6	8·5	6	14·8	9	9·9	6	7·7	7	10·4
Caul fat	2	11·9	6	1·3	9	10·5	6	9·7	9	1·1	7	1·8
Small intestines and contents	2	2·6	2	12·4	2	4·1	2	4·7	2	4·2	2	7·6
Large intestines and contents ..	2	11·5	2	12	3	0·9	3	2·3	2	15·9	2	15·2
Intestinal fat ..	1	2·6	2	7·8	4	3·6	3	2·4	4	5·6	3	2·2
Heart and aorta ..	0	7·1	0	9·3	0	11	0	11·4	0	11·1	0	10·4
Heart fat	0	4·9	0	4·8	0	10·7	0	9·6	0	11·3	0	7·8
Lungs and windpipe	1	1·5	1	8·2	1	9·5	1	8	1	9	1	8·3
Blood	4	7·3	6	0·2	7	2·5	5	9·4	6	8·8	6	1·6
Liver	1	8·1	2	8·2	2	8·8	2	0·6	2	5·3	2	5·4
Gall-bladder and contents	0	1	0	1·4	0	1·8	0	1·5	0	1·3	0	1·5
Pancreas ("sweet-bread")	0	2·1	0	3·5	0	3·1	0	3·4	0	3·3	0	3·3
Glands about the throat ("throat-bread")	0	0·8	..		..		..		..		..	
Milt or spleen ..	0	2·6	0	4	0	4·4	0	3·6	0	4·7	0	4·0
Bladder	0	0·8	0	0·7	0	0·9	..		0	0·8	0	0·8
Head	3	5·9	4	5·2	4	12·3	4	9·7	4	11·4	4	8·1
Skin .. .. .. / Wool .. .. .. / Feet and hoofs ..	13	1·8	18	9·8	20	0·9	16	4·5	18	7·9	18	0·4
Diaphragm ("skirts")	0	4·1	..		0	3·4	..		..		0	3·4
Miscellaneous trimmings	0	1·4	0	3·1	0	3·0	..		0	2·0	0	3·0
Total "Offal" parts ..	42	12·0	58	14·2	68	12·1	60	8·2	64	10·6	61	11·5
Carcass	49	11·8	85	11·1	122	14·9	80	6·3	106	5·7	91	12·5
Loss by evaporation, error in weighing, &c.	0	9·0	0	12·0	0	5·3	0	8·2	−0	4·1	0	2·2
Live-weight after fasting	93	0·8	145	5·3	192	0·3	141	6·7	170	12·2	153	10·2

Table VI.

Mean Actual Weights (lbs. and ozs.) of the different Organs and Parts of—

Pigs.

Description of Parts.	Moderately Fattened on different descriptions of Food. Means of														59 Fattened Pigs.	
	9 Pigs. Food: Bran, with limited Quantity of Bean and Lentil Meal, or Indian Meal, or both.		12 Pigs. Food: Bean and Lentil Meal, with limited Quantity of Indian Meal, or Bran, or both.		15 Pigs. Food: Indian Meal, with limited Quantity of Bean and Lentil Meal, or Bran; or all ad lib.		12 Pigs. Food: Sugar, or Starch, or both, with limited Quantity of Bran and Lentil Meal.		6 Pigs. Food: Dried Cod-fish, with Indian Meal, or Bran and Indian Meal.		2 Pigs. Put to Feed in Store condition, and only half Fattened.		3 Pigs. Put to Feed when half Fat, on same Food as last, and moderately Fattened.			
	lbs.	ozs.	lbs.	ozs.	lbs.	ozs.	lbs.	ozs.	lbs.	ozs.	lbs.	ozs.	lbs.	ozs.	lbs.	ozs.
Original weight	140	12·5	142	9·4	143	7·5	95	5·3	163	13·3	130	8	135	10·7	134	5·1
Final weight, unfasted ..	191	7·1	239	5·4	235	10·7	185	4	287	13·3	180	0	181	5·3	220	1·1
Fasted live-weight	182	12·4	227	6·9	234	12·7	177	6.6	278	0	170	8	172	10·8	212	12
Separate parts of the "Offal."																
Stomachs .. .. .. / Contents of stomachs	3	0·6	2	13	2	11·4	2	0·8	3	2·9	2	15·3	1	11·3	2	10·4
Caul fat	0	15·2	1	2	1	5·2	1	0·9	1	6·8	0	12·8	0	14·3	1	2·3
Small intestines and contents	5	10·3	4	14·8	3	14·9	3	13·2	4	8·1	6	10	3	15·1	4	8·4
Large intestines and contents	9	1·4	9	5·4	7	10·8	8	14·3	7	9·6	7	6	5	10·3	8	5·7
Intestinal fat, "mudgeon," &c.	1	10·8	3	·4	3	3·6	1	1·7	2	14·3	1	2·6	1	8·2	2	5·6
Heart and aorta	0	8·5	0	9·9	0	10·4	0	8·9	0	11·1	0	7·5	0	8·1	0	9·6
Lungs and windpipe ..	1	9·7	1	10·2	1	9·5	1	6·4	1	9·4	1	6·5	1	12·3	1	9·1
Blood	7	3·8	9	2	8	0·4	6	5·2	8	9·4	5	3·3	5	12·7	7	10·1
Liver	2	13·5	3	14·3	3	5·6	3	0·1	3	7	3	2·1	2	10·1	3	4·5
Gall-bladder and contents	0	2·1	0	2·1	0	1·7	0	2·4	0	2·8	0	1·6	0	2·4	0	2·1
Pancreas ("sweet-bread")	0	5·1	0	8·1	0	7·5	0	5	0	8·1	0	4·5	0	5·1	0	6·6
Milt or spleen	0	4·7	0	5·4	0	4·7	0	3·7	0	5·6	0	4·6	0	4·5	0	4·7
Bladder	0	1·9	0	3·1	0	2·7	0	2·2	0	2·7	0	1·8	0	2·6	0	2·5
Penis	0	6·8	0	8·1	0	8	0	5·6	0	9·2	0	5·1	0	6·8	0	7·1
Tongue	0	15·7	1	0·3	1	0·8	0	15·2	1	3·3	0	13·2	0	13·6	1	0·2
Toes	0	2·9	0	3·3	0	2·9	0	2·3	0	3	..		..		0	2·9
Miscellaneous trimmings	0	5·1	0	11·8	0	11·7	0	3·5	0	9·1	0	9·3	0	10·4	0	8·8
Total "Offal" parts	35	6·1	40	4·2	35	15·8	30	11·4	37	10·4	31	10·2	27	3·8	35	4·6
Carcass (including head with brains, feet, and tail)	146	7·5	186	14·4	197	12·5	144	9·5	239	6	135	9·5	144	6·2	176	5·3
Loss by evaporation, error in weighing, &c.	0	14·8	0	4·3	1	0·4	2	1·7	0	15·6	3	4·3	1	0·8	1	2·1
Live-weight after fasting ..	182	12·4	227	6·9	234	12·7	177	6·6	278	0	170	8	172	10·8	212	12

Table VII.

Mean Percentage Proportion of the different Organs and Parts in the Fasted Live-weight of—

Calves, Heifers, and Bullocks.

	Description of Parts.	Means of			
		2 Fat Calves.	2 Fat Heifers.	14 Fat Bullocks.	2 Heifers and 14 Bullocks.
Separate parts of the "Offal".	Stomachs	1·37	3·75	3·09	3·17
	Contents of stomachs	1·89	8·40	8·33	8·34
	Caul fat..	1·03	2·69	1·93	2·02
	Small intestines and contents	2·13	1·80	1·57	1·60
	Large intestines and contents	1·30	1·44	1·21	1·24
	Intestinal fat..	1·13	3·02	2·12	2·24
	Heart and aorta	0·60	0·48	0·50	0·50
	Heart fat	0·08	0·22	0·32	0·31
	Lungs and windpipe	1·32	0·75	0·82	0·81
	Blood	4·68	3·60	4·07	4·01
	Liver	1·67	1·52	1·28	1·31
	Gall-bladder and contents	0·05	0·08	0·09	0·09
	Pancreas ("sweetbread")		0·09	0·09	0·09
	Thymus gland ("heartbread") ..	0·67	0·07	0·06	0·06
	Glands about the throat ("throat-bread")		0·05	0·03	0·03
	Milt or spleen	0·32	0·15	0·17	0·16
	Bladder..	0·15	0·06	0·05	0·05
	Penis		..	0·04	..
	Brains			0·07	0·06
	Tongue	5·46	2·51	2·71	2·69
	Head				
	Hide	6·94	7·74	7·46	7·49
	Feet and hoofs	2·18	1·72	1·78	1·77
	Tail	0·13	0·09	0·09	0·10
	Diaphragm ("skirts")	0·44	0·53	0·39	0·41
	Miscellaneous trimmings	..	0·49	0·27	0·30
	Total "Offal" parts	33·54	41·25	38·54	38·85
	Carcass	63·13	55·58	59·84	59·31
	Loss by evaporation, error in weighing, &c.	3·33	3·17*	1·62	1·84
		100·00	100·00	100·00	100·00

* This amount includes the wombs of the Heifers, one of which was with Calf.

Table VIII.

Mean Percentage Proportion of the different Organs and Parts in the Fasted Live-weight of—

Sheep.

DESCRIPTION OF PARTS.	Means of — Gradationary Series. 5 Sheep of different Breeds, killed in Store condition, for a standard of comparison.	Gradationary Series. 100 Sheep of different Breeds, moderately Fattened. About 1¼ Year old.	Gradationary Series. 45 Sheep of different Breeds, excessively Fattened. About 1¾ Year old.	Miscellaneous. 78 Hants Down Sheep, moderately Fattened on different Foods. 1¼ to 1½ Year old.	Miscellaneous. 21 Sheep of various Breeds and Modes of Feeding, of more than Average Fatness. About 1¾ Year old.	249 Sheep of different Breeds, conditions of Fatness, Age, &c.
Separate parts of the "Offal."						
Stomachs	2·94	2·49	2·14	2.72	2·17	2·45
Contents of stomachs	6·16	4·49	3·62	6·83	3·85	4·98
Caul fat	2·92	4·13	4·99	4·67	5·18	4·63
Small intestines and contents ..	2·32	1·92	1·19	1·63	1·33	1·61
Large intestines and contents ..	2·93	1·89	1·59	2·23	1.75	1·92
Intestinal fat	1·28	1·70	2·10	2·23	2·55	2·04
Heart and aorta	0·48	0·40	0·36	0·51	0·41	0·43
Heart fat	0·32	0·20	0·35	0·42	0·42	0·32
Lungs and windpipe	1·17	1·04	0·83	1·06	0·92	0·99
Blood	4·81	4·14	3·73	3·95	3·84	3·97
Liver	1·61	1·75	1·33	1·44	1·37	1·52
Gall-bladder and contents	0·07	0·06	0·06	0·07	0·05	0·06
Pancreas ("sweetbread")	0·13	0·15	0·10	0·15	0·12	0·14
Glands about the throat ("throat-bread")	0·06	..	..	..	..	..
Milt or spleen	0·17	0·17	0·14	0·16	0·17	0·16
Bladder	0·05	0·03	0·03	..	0·03	0·03
Head	3·64	3·00	2·53	3·27	2·74	2·93
Skin .. .. }						
Wool .. .. }	14·09	12·83	10·46	11·50	11·01	11·73
Feet and hoofs .. .. }						
Diaphragm ("skirts")	0·30	..	0·12	..	..	0·14
Miscellaneous trimmings	0·10	0·13	0·11	..	0·07	0·12
Total "Offal" parts	45·55	40·52	35 78	42·84	37·98	40·17
Carcass	53·42	58·97	64·05	56·85	61·91	59·74
Loss by evaporation, error in weighing, &c.	1·03	0·51	0·17	0·31	0·11	0·09
	100·00	100·00	100·00	100.00	100·00	100·00

TABLE IX.

Mean Percentage Proportion of the different Organs and Parts in the Fasted Live-weight of—

PIGS.

	DESCRIPTION OF PARTS.	Moderately Fattened on different descriptions of Food. Means of							
		9 Pigs. Food: Bran, with limited Quantity of Bean and Lentil Meal, or Indian Meal, or both.	12 Pigs. Food: Bean and Lentil Meal, with limited Quantity of Indian Meal, or Bran, or both.	15 Pigs. Food: Indian Meal, with limited Quantity of Bean and Lentil Meal, or Bran; or all ad lib.	12 Pigs. Food: Sugar, or Starch, or both, with limited Quantity of Bran and Lentil Meal.	6 Pigs. Food: Dried Cod-fish, with Indian Meal, or Bran and Indian Meal.	2 Pigs. Put to Feed in Store condition, and only half Fattened.	3 Pigs. Put to Feed when half Fat, on same Food as last, and moderately Fattened.	59 Fattened Pigs.
Separate parts of the "Offal."	Stomachs .. .. / Contents of stomachs	1·66	1·27	1·18	1·16	1·17	1·81	0·99	1·28
	Caul fat	0·52	0·49	0·57	0·59	0·51	0·47	0·52	0·54
	Small intestines and contents	3·05	2·19	1·69	2·15	1·66	3·98	2·36	2·20
	Large intestines and contents	4·91	4·16	3·28	5·05	2·76	4·34	3·38	4·04
	Intestinal fat, "mudgeon," &c.	0·91	1·35	1·37	0·63	1·03	0·67	0·87	1·06
	Heart and aorta ..	0·29	0·27	0·27	0·31	0·25	0·28	0·29	0·29
	Lungs and windpipe	0·88	0·73	0·68	0·79	0·57	0·85	1·06	0·76
	Blood	3·97	4·08	3·43	3·59	3·11	3·04	3·37	3·63
	Liver	1·55	1·71	1·43	1·70	1·26	1·87	1·56	1·57
	Gall-bladder and contents	0·07	0·05	0·05	0·08	0·06	0·05	0·09	0·06
	Pancreas ("sweet-bread")	0·18	0·22	0·20	0·18	0·19	0·17	0·18	0·19
	Milt or spleen ..	0·16	0·15	0·13	0·14	0·12	0·17	0·15	0·14
	Bladder	0·07	0·09	0·07	0·08	0·06	0·06	0·10	0·08
	Penis	0·23	0·22	0·21	0·20	0·21	0·18	0·24	0·21
	Tongue	0·54	0·46	0·45	0·53	0.43	0·49	0·51	0·48
	Toes	0·09	0·09	0·08	0·08	0·07	..	..	0·08
	Miscellaneous trimmings	0·18	0·32	0·29	0·12	0·21	0·35	0·40	0·26
	Total "Offal" parts ..	19·26	17·85	15·38	17·38	13·67	18·78	16·07	16·87
	Carcass (including head with brains, feet, and tail)	80·22	82·07	84·18	81·44	85·98	79·26	83·39	82·57
	Loss by evaporation, error in weight, &c.	0·52	0·08	0·44	1·18	0·35	1·96	0·54	0·56
		100·00	100·00	100·00	100·00	100·00	100·00	100·00	100·00

blood, all taken together, give an average *actual* weight per head—for the five *store* sheep of 7¾ lbs., for the hundred *fat* ones of 11¾ lbs., and for the forty-five *very fat* ones of 12½ lbs. The rate of increase in actual weight as the animals fatten is, therefore, rather greater for these last-mentioned organs or parts than for the collective stomachs and intestines, and contents. Still, they *decrease*—though not so much as the collective stomachs, &c.—in percentage to the whole body with the increase in weight and fatness of the animals. Thus, the percentage of the heart and other parts above classed with it is, for the average of the five *store* sheep 8·44, for that of the hundred *fat* ones 7·71, and for that of the forty-five *very fat* ones 6·55.

Of the internal parts, the *loose fat alone* increases in both actual weight, and percentage proportion, with the progress of the animals. It averages in *actual weight*—for the store or lean sheep about 4¼ lbs., for the fat ones about 8¾ lbs., and for the very fat ones about 14½ lbs. In *percentage proportion* it averages—for the lean sheep 4·52, for the fat ones 6·03, and for the very fat ones 7·44.

The results, as regards the collective or *total* offal parts, and the *total* carcass parts, respectively, are as follow:—The total offal parts increased in average *actual weights* per head, from 42¾ lbs. in the *store* or *lean* condition, to 58¾ lbs. in the *fat*, and to 68¾ lbs. in the *very fat* condition. The increase in actual weight of the corresponding carcasses was much greater, namely, from 49¾ lbs. in the *store*, to 85¾ lbs. in the *fat*, and to nearly 123 lbs. in the *very fat* condition.

The result is, then, that although the collective internal organs and other offal parts increase considerably as the animals fatten, the so-called carcass or frame—with its muscles, membranes, vessels, and fat—increases very much more rapidly.

It follows, of course, that there is a *diminishing percentage* in the entire body of the total offal parts, and an *increasing percentage* of the total carcass parts, as the animals mature and fatten. Thus, the percentage of the collective offal parts is, in round numbers—for the average of the *lean* sheep 45·5, for that of the *fat* ones 40·5, and for that of the *very fat* ones 35·8. The percentages of the carcass parts were, on the other hand—for the corresponding *lean* animals 53·4, for the *fat* ones 58·9, and for the *very fat* ones 64·0.*

The practical importance of these facts will be better seen if they are stated in another form. Thus it follows, from the data

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* It will be noticed that the sums of the corresponding offal and carcass parts, here quoted, do not quite make up 100. The complementary amounts represent the loss by evaporation, error in weighing, &c.

involved, that of the *increase* from the lean to the fat condition 68·8 per cent., and of the *increase* from the fat to the very fat condition 79·8 per cent., would be saleable carcass. It may perhaps be estimated that 65 to 70 per cent. of the gross increase of oxen and sheep, liberally fattening over a considerable period of time, will be saleable carcass. Calculations of a similar kind in regard to pigs, show that of their *increase* during the last two or three months of liberal feeding, little less than 90 per cent. (including head and feet) may be reckoned as saleable carcass.

Again, the mean percentage of *loose fat* (caul, intestinal, and heart together) in the fat sheep, as slaughtered, was only 6·03; but the percentage in the *increase* from the store to the fat condition would be 8·91. In the same way, though the average percentage of loose fat in the very fat sheep was only 7·44, the percentage in the *increase* from the fat to the very fat condition would be 12·17.

On the other hand, the percentage of the other offal parts (that is, excluding loose fat) was in the lean animals 41·03, and in the fat animals 34·49; but the percentage of these collective parts in the *increase* from the lean to the fat condition would be only 21·96. Lastly, the percentage of the same offal parts in the very fat animals was 28·34, whilst the percentage in the *increase* from the fat to the very fat condition would be only 8·97.

From the few summary statements that have been adduced, it is sufficiently obvious that, in the feeding or fattening of animals, the apparatus which subserves for the reception, the transmission, and the elaboration of the food, does not increase so rapidly as the saleable carcass or framework—with its covering of flesh and fat—which it is the object of the feeder to store up from that food. It will be seen, when we come to treat of the *chemical* composition of the animals, and of their increase, which of these two main constituents of the carcasses—the *flesh* or the *fat*—increases the most rapidly. From the facts given in this section, it is obvious that of the internal, or "offal" parts, at least, it is the *fat* which increases the most rapidly.

The illustrations of the order of development of the different organs and parts of fattening animals, given above, have been drawn from the results obtained on slaughtering large numbers of sheep, at different ages and degrees of maturity, without special reference to the character of the food employed.

That the character of the fattening food—even within the period of only a few weeks—has a marked influence upon the character of the development, and consequently upon that of the meat produced, is shown by a careful consideration of the results relating to the slaughtered pigs, recorded in Tables VI. and IX.

In

TABLE X.—Amounts and Proportion of the Fat and of the Lean parts, (Average of

Pen Nos.	Number of Pigs.	Description of Food. Given in Limited Quantity.	Description of Food. Given *ad libitum*.	Non-Nitrogenous Substance to 1 Nitrogenous Substance in Food.	Increase for 100 Dry Substance in Food.	Increase upon 100 Original Weight.	Per Cent. Carcass in Fasted Live-Weight.
9	3	2 lbs. bean and lentil meal	Bran	2·64	13·0	23·3	78·5
10	3	2 lbs. Indian corn meal . .	Bran	4·77	12·7	27·4	81·0
11	3	2 lbs. bean and lentil meal, and 2 lbs. Indian-corn meal	Bran	3·43	18·5	42·1	81·2
1	3	None	Bean and lentil meal	1·99	22·9	68·9	81·9
2	3	2 lbs. Indian-corn meal .	Bean and lentil meal	2·43	24·3	79·6	83·0
3	3	2 lbs. bran	Bean and lentil meal	2·31	17·7	47·4	81·2
4	3	2 lbs. bran, and 2 lbs. Indian-corn meal . . .	Bean and lentil meal	2·91	20·2	59·0	82·2
5	3	None	Indian-corn meal . .	6·61	22·1	51·3	85·4
6	3	2 lbs. bean and lentil meal	Indian-corn meal . .	4·65	23·8	67·0	84·4
7	3	2 lbs. bran	Indian-corn meal . .	5·69	24·9	74·5	83·7
8	3	2 lbs. bran, and 2 lbs. bean and lentil meal . . .	Indian-corn meal . .	4·26	25·3	80·3	83·5
12	3	None	Bean and lentil meal, Indian-corn meal, and bran	3·28	21·1	59·7	83·9
13	3	2 lbs. dried cod-fish . . .	Bran and Indian-meal (equal parts) . . .	3·13	21·6	51·1	84·6
14	3	2 lbs. dried cod-fish . . .	Indian-meal	3·80	26·2	60·1	87·3

MEANS.

Pens	Description of Food	Non-Nitrogenous Substance to 1 Nitrogenous Substance in Food.	Increase for 100 Dry Substance in Food.	Increase upon 100 Original Weight.	Per Cent. Carcass in Fasted Live-Weight.
Pens 9, 10, 11	Bran, with limited quantity of bean and lentil meal, or Indian-meal, or both	3·61	14·7	30·9	80·2
,, 1, 2, 3, 4	Bean and lentil meal, with limited quantity of Indian-meal, or bran, or both	2·41	21·3	63·7	82·1
,, 5, 6, 7, 8, 12 .	Indian-meal, with limited quantity of bean and lentil meal, or bran, or all	4·90	23·4	66·6	84·2
13, 14 .	Dried cod-fish, with Indian-meal, or bran and Indian meal	3·46	23·9	55·6	86·0
General Means		3·71	21·0	56·5	83·0

respectively, in the Carcasses of Pigs fed on different descriptions of Food.
3 Pigs in each case).

ACTUAL WEIGHTS OF SEPARATED PARTS OF CARCASS.						PER CENT. IN TOTAL CARCASS.				
Fat Parts.			Total Lean Parts: Legs, Ribs, Shoulders, Shoulder-blades, Head, and Feet.	Loss by Evaporation, &c.	Total Carcass.	Fat Parts.			Total Lean Parts: Legs, Ribs, Shoulders, Shoulder-blades, Head, and Feet.	Loss by Evaporation, &c.
Inside Fat, or "Flare" (with Kidneys).	Outside Fat, or Flitch.	Total Fat Parts.				Inside Fat, or "Flare" (with Kidneys).	Outside Fat, or "Flitch."	Total Fat Parts.		
lbs. ozs.	lbs. ozs.	lbs. ozs.	lbs. ozs.	lbs. ozs.	lbs. ozs.					
7 6	40 1	47 7	83 5	4 4	135 0	5·46	29·7	35·2	61·7	3·15
9 4	47 15	57 3	81 11	4 8	143 6	6·45	33·4	39·9	57·0	3·15
10 6	55 5	65 11	90 13	4 8	161 0	6·45	34·4	40·8	56·4	2·80
12 7	69 2	81 9	105 10	9 10	196 13	6·32	35·1	41·4	53·7	4·90
13 0	82 1	95 1	105 11	7 8	208 4	6·24	39·4	45·6	50·8	3·60
10 11	55 6	66 1	91 15	5 11	163 11	6·53	33·8	40·3	56·2	3·46
10 5	64 1	74 6	98 14	5 10	178 14	5·76	35·8	41·6	55·3	3·14
12 5	70 4	82 9	95 6	5 2	183 1	6·73	38·4	45·1	52·1	2·80
12 4	81 1	93 5	107 4	5 10	206 3	5·94	39·3	45·2	52·0	2·72
13 3	75 5	88 8	105 1	5 9	199 2	6·62	37·8	44·4	52·8	2·78
14 12	82 3	96 15	110 7	5 10	213 0	6.92	38·6	45·5	51·8	2·63
11 13	75 6	87 3	97 7	2 15	187 9	6·30	40·2	46·5	51·9	1·57
12 10	88 6	101 0	113 0	5 1	219 1	5·76	40·3	46·1	51·6	2·30
14 9	114 8	129 1	125 4	5 7	259 12	5·60	44·1	49·7	48·2	2·08
MEANS.										
9 0	47 12	56 12	85 5	4 7	146 8	6·12	32·5	38·6	58·4	3·03
11 10	67 10	79 4	100 9	7 1	186 14	6·21	36·0	42·2	54·0	3·77
12 14	76 13	89 11	103 2	5 0	197 13	6·50	38·9	45.4	52·1	2·50
13 10	101 7	115 1	119 2	5 3	239 6	5·68	42·2	47·9	49·9	2·19
11 13	71 8	83 5	100 13	5 8	189 10	6·22	37·2	43·4	53·7	2·93

In order, however, to get some further direct experimental evidence on the point, the carcasses of most of these slaughtered pigs were separated by the butcher into—

1. Inside fat or "flare" (with kidneys).
2. Outside fat or "flitch."
3. Legs, ribs, and shoulder-blade.
4. Shoulders or "hands."
5. Head and feet.

Table X. (pp. 452, 453) gives a summary of the results of these separations.

The general result is, that when the proportion of *non*-nitrogenous to nitrogenous substance in the food was comparatively high, the proportion of carcass in the live-weight was also comparatively high; and the carcasses themselves at the same time comprised a larger proportion of the fat, and a less one of the lean, parts. There cannot be a doubt that those animals which yielded the largest proportion of carcass, and whose carcasses consisted in the larger proportion of the fat parts, would be those most valued by the consumer, and for which the feeder would get the highest price.*

Attention has already been called to the fact, that, taking only the price of the *food* and the value of the *manure* into consideration, it would be the interest of the farmer to employ the more highly nitrogenous foods pretty liberally. It was shown, on the other hand, that when the proportion of nitrogenous to non-nitrogenous substance in the food exceeded a stated amount, the proportion of increase in live-weight obtained, for a given amount of food, was either less or but very little greater. It is now further seen, that with an excessive proportion of nitrogenous substance in the food, the proportion of carcass was less, and the proportion of the carcass itself that consisted of the more valued fat parts, was also less. In fact, at any rate during the last few weeks of the fattening of pigs, the proportion of nitrogenous to non-nitrogenous substance in the food should very little exceed that existing in the cereal grains.

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* In connexion with the question of the influence of the food, and the character of development of the animal, upon the character and value of the meat produced, it may here be further mentioned, that in the case of some of the *sheep* that were fed experimentally upon different foods, joints from selected animals were roasted, and the weights of the cooked meat, the dripping, and the loss by evaporation, determined. The result was, that both the leg and the loin of a sheep that had been fattened upon *steeped* barley, and mangolds, and which gave a very rapid increase, gave several per cent. less cooked meat, and lost more both of fat in the form of dripping, and of water, than the corresponding joints of a sheep which had been fed upon *dry* barley, and mangolds, and which gave only about half the amount of gross increase within the same period of time.

III.—Chemical Composition of Oxen, Sheep, and Pigs, in different conditions of Growth and Fatness.

The mineral matter, the nitrogenous substance, and the fat, have been determined in certain separated parts, and in the entire bodies, of 10 animals, namely:—

1. A fat calf—of the Durham breed; 9 or 10 weeks old; taken from the dam feeding upon grass; killed September 12, 1849.
2. A half-fat ox—Aberdeen breed; about 4 years old; fed on fattening food; but which had grown rather than fattened; killed November 14, 1849.
3. A moderately fat ox—Aberdeen breed; about 4 years old; fed on fattening food; killed October 30, 1849.
4. A fat lamb—Hampshire Down; about 6 months old; killed August 17, 1849.
5. A store sheep—Hampshire down; about a year old; killed February 28, 1850.
6. A half-fat old sheep—Hampshire Down ewe; 3¼ years old; killed May 3, 1849.
7. A fat sheep—Hampshire Down; 1¼ year old; killed May 7, 1849.
8. A very fat sheep—Hampshire Down; 1¾ year old; killed December 13, 1848.
9. A store pig; killed May 12, 1850.
10. A fat pig; same litter as last; fed on fattening food for 10 weeks; killed July 18, 1850.

Of the 10 animals analysed, the store sheep and the store pig were certainly in a much leaner condition than that in which sheep and pigs are usually, if ever, slaughtered for food in this country. Sometimes, though seldom, oxen and sheep may be killed in as lean a state as the "half-fat ox," and the "half-fat old sheep." The "fat calf," the "fat ox," the "fat lamb," and the "fat sheep," may perhaps be taken as fairly representing the average conditions, respectively, of such animals of reputed good quality, and admitted to be properly fattened. The "extra fat sheep" was, undoubtedly, considerably fatter than mutton as usually killed; it was, in fact, in the condition of what is called "Christmas mutton." The "fat pig" was somewhat larger and fatter than the average of the animals consumed in large proportion as fresh pork; but certainly less, and not so fat, as the average of those fed and slaughtered more exclusively for curing.

The composition of the *carcass*, and of the *offal*, respectively, of each of the 10 animals, is given in Table XI. (p. 456); and that of the *entire bodies* in Table XII. (p. 457.)

Table XI.

Percentages of Mineral Matter, Nitrogenous Compounds, Fat, Total Dry Substance, and Water, in the *Carcasses*, and in the *Offal*, respectively, of 10 Animals of different descriptions, or in different conditions of Growth and Fatness.

Description of Animal.	Mineral Matter (Ash).	Nitrogenous Compounds (Dry).	Fat (Dry).	Total Dry Substance.	Water.
			Per Cent. in Carcass.		
Fat Calf	4·48	16·6	16.6	37·7	62·3
Half-fat Ox	5·56	17·8	22·6	46·0	54·0
Fat Ox	4·56	15·0	34·8	54·4	45·6
Fat Lamb	3·63	10·9	36·9	51·4	48·6
Store Sheep	4·36	14·5	23·8	42·7	57·3
Half-fat old Sheep	4·13	14·9	31·3	50·3	49·7
Fat Sheep	3·45	11·5	45·4	60·3	39·7
Extra fat Sheep	2·77	9·1	55·1	67·0	33·0
Store Pig	2·57	14·0	28·1	44·7	55·3
Fat Pig	1·40	10·5	49·5	61·4	38·6
Means of all	3·69	13·5	34·4	51·6	48·4
	Per Cent. in Offal (= sum of Parts, excluding Contents of Stomachs and Intestines).				
Fat Calf	3·41	17·1	14·6	35·1	64·9
Half-fat Ox	4.05	20·6	15·7	40·4	59·6
Fat Ox	3.40	17·5	26·3	47·2	52·8
Fat Lamb	2·45	18·9	20·1	41·5	58·5
Store Sheep	2·19	18·0	16·1	36·3	63·7
Half-fat old Sheep	2·72	17·7	18·5	38·9	61·1
Fat Sheep	2·32	16·1	26·4	44·8	55·2
Extra fat Sheep	3·64	16·8	34·5	54·9	45·1
Store Pig	3·07	14·0	15·0	32·1	67·9
Fat Pig	2·97	14·8	22·8	40·6	59·4
Means of all	3·02	17·2	21·0	41·2	58·8

For a full discussion of the composition of these 10 animals, and more especially for a consideration of the bearing of the results upon the question of the probable average composition of the *meat* consumed as human food, and its relations to *bread*, the reader is referred to our Paper in the Transactions of the Royal Society, already quoted. We can here do little more than call attention to the composition of the *animals*, and of their *increase*,

TABLE XII.

Percentages* of Mineral Matter, Nitrogenous Compounds, Fat, Total Dry Substance, and Water, in the *Entire Bodies* of Ten Animals, of different Descriptions, or in different Conditions of Growth and Fatness.

DESCRIPTION OF ANIMAL.	PER CENT. IN FASTED LIVE-WEIGHT.															
	Mineral Matter (ash).			Nitrogenous Compounds (dry).			Fat (dry).			Total Dry Substance.			Water.			Contents of Stomachs and Intestines (in moist state).
	From Carcass parts.	From Offal parts.	From Total parts.	From Carcass parts.	From Offal parts.	From Total parts.	From Carcass parts.	From Offal parts.	From Total parts.	From Carcass parts.	From Offal parts.	From Total parts.	From Carcass parts.	From Offal parts.	From Total parts.	
Fat Calf	2·78	1·02	3·80	10·3	5·1	15·4	10·3	4·3	14·6	23·4	10·5	33·9	41·9	21·1	63·0	3·17
Half-fat Ox	3·60	1·06	4·66	11·5	5·4	16·9	14·6	4·1	18·7	29·7	10·6	40·3	35·6	15·9	51·5	8·19
Fat Ox	3·02	0·90	3·92	10·0	4·6	14·6	23·1	7·0	30·1	36·1	12·5	48·6	30·8	14·7	45·5	5·98
Fat Lamb	2·17	0·76	2·93	6·5	5·9	12·4	22·1	6·3	28·4	30·8	12·9	43·7	29·3	18·4	47·7	8·54
Store Sheep	2·32	0·84	3·16	7·7	6·9	14·6	12·7	6·2	18·9	22·8	13·9	36·7	31·8	25·5	57·3	6·00
Half-fat old Sheep	2·21	0·96	3·17	7·8	6·3	14·1	16·7	6·5	23·2	26·9	13·7	40·6	27·7	22·6	50·3	9·05
Fat Sheep	1·98	0·83	2·81	6·6	5·7	12·3	26·1	9·4	35·5	34·7	16·0	50·7	23·2	20·1	43·3	6·02
Extra-fat Sheep ..	1·75	1·15	2·90	5·7	5·3	11·1	34·7	10·9	45.6	42·2	17·4	59·6	20·9	14·3	35·2	5·18
Store Pig	1·71	0·96	2·67	9·3	4·4	13·7	18·7	4·7	23·4	29·7	10·0	39·7	43·8	11·2	55·0	5·22
Fat Pig	1·06	0·59	1·65	8·0	2·9	10·9	37·6	4·5	42·1	46·7	8.0	54·7	36·4	5·0	41·4	3·97
Means of all ..	2·26	0·91	3·17	8·3	5·3	13·6	21·7	6·4	28·1	32·3	12·6	44·9	32·1	16·9	49·0	6·13

* In the above Table the percentages headed "From Total Parts" are the *sums* of those in the Carcass and "Offal" parts given in the two preceding columns; and will be found in some cases, to differ slightly from those given in Table VII. of our Paper in the Transactions of the Royal Society, which are calculated from the direct determinations on the *entire bodies* themselves. The agreement of the figures obtained by the two methods, is, however, in all cases, so near, that the results are mutually confirmatory.

increase, and its relation to that of the food consumed: that is, considering them in the light of manufactured articles, produced by the farmer from certain raw materials.

All the results tend to show a prominent connection between the proportion of the *mineral* matters, and that of the *nitrogenous* constituents of the body—there being a general disposition to a rise or fall in the percentage of mineral matter, with the rise or fall in that of the nitrogenous compounds. It has already been seen, that the bony and fleshy parts were the more developed when the food was somewhat highly nitrogenous.

Composition of the Carcasses.

Looking first to the composition of the different *carcasses*, it is seen, that in every instance, excepting that of the calf, there was considerably more of dry *fat* than of dry *nitrogenous* compounds.

In the carcass of even the *store* or *lean* sheep, there was more than one and a half time as much fat as nitrogenous substance; and in that of the *store* or *lean* pig, there was twice as much. In the carcass of the half-fat ox there was one-fourth more fat than nitrogenous matter; and in that of the half-fat old sheep, there was more than twice as much.

Of the *fatter* animals, the carcass of the fat ox contained twice and one-third as much dry fat as nitrogenous substance; that of the fat sheep four times, and that of the very fat sheep, even six times as much. Lastly, in the carcass of the moderately fat pig, there was nearly five times as much fatty matter as nitrogenous compounds.

From these results it may, perhaps, be safely inferred, that in the carcasses of *beef*, of reputed good condition, there will be seldom less than twice as much, and frequently nearly three times as much dry fat as dry nitrogenous substance. In the carcasses of *sheep* we should conclude, that the fat would generally amount to more than three, and frequently to four or even more, times as much as the nitrogenous matter. Finally, it may be estimated that in the carcasses of *pigs killed for fresh pork*, there will frequently be about four times as much fat as nitrogenous compounds; whilst, in those *fed for curing*, the fat will be in a considerably higher proportion.

The *fat* of the bones bears but a small proportion to that of the whole carcass, whilst of the whole *nitrogen* of the carcasses, perhaps not less than one-fifth will be in their bones.

As the animal matures, the mineral, the nitrogenous, and the fatty matters, all increase in *actual* amount; but the *percentage* in the carcass of both mineral matter and nitrogenous substance decreases, whilst that of the fat increases so as to much more

than compensate for the decrease in that of the other solid matters. The result is, that there is an increase in the percentage of *total dry substance.*

In the carcasses of the leaner animals there were from 54 to 62 per cent. of water; namely, in that of the calf $62\frac{1}{4}$, of the store sheep $57\frac{1}{3}$, of the store pig $55\frac{1}{3}$, and of the half-fat ox 54 per cent. The carcasses of all the other animals contained less than 50 per cent., and those of the fattest less than 40 per cent., of water. That of the moderately-fattened ox contained $45\frac{1}{2}$, of the fat lamb $48\frac{2}{3}$, of the half-fat sheep $49\frac{2}{3}$, of the fat sheep $39\frac{2}{3}$, and of the very fat sheep only 33, per cent. of water. Lastly, in the carcass of the moderately-fattened pig there were $38\frac{1}{2}$ per cent. of water. Between the condition in which these particular carcasses were taken for analysis and that in which the meat would be sold by the butcher, from 1 to 2 per cent., or perhaps more, of water would be lost by evaporation.

The bones contain a higher percentage of dry matter than the collective soft parts. The proportion of bone is the highest in oxen, less in sheep, and still less in pigs. It is, too, the less the fatter the animal. The percentage of dry matter in the bone increases as the animal matures.

From the whole of the data adduced on the point, it may perhaps be safely concluded that the average of well-fattened carcass-*beef* will contain 50 per cent., or rather more, of dry substance; that of properly-fattened mutton rather more than beef—say 55 to 60 per cent.; that of pigs killed for fresh pork rather more than sheep; and the sides of pigs killed for curing still more. Lamb carcasses appear to contain a smaller proportion of dry substance than either moderately-fattened beef, mutton, or pork. But, of all, the carcass of the calf contains the least proportion of dry substance; and, at the same time, its proportion of bone is higher than in that of any other of the animals.

Such, then, is the composition of the *carcass*, or that part of the animal which it is the object of the feeder to develop as much as possible.

Composition of the Offal.

Upon the composition of the collective *offal* parts very few comments on the records given in the Table need be made.

The percentage of *mineral matter*, mainly dependent on the proportion of bone, is generally less in the collective offal than in the collective carcass parts. It is, too, in the former less than the figures in the Table indicate; for these include a quantity of adventitious dirt, which it was impossible to remove from the hair of the oxen, but more particularly from the wool of the sheep, and especially from that of the extra-fat one.

The percentage of *dry nitrogenous substance* is in every case greater, and that of the *fat* very much less, in the collective offal than in the collective carcass parts. A very large proportion of the nitrogenous substance of the offal—in some cases nearly half—is due to the pelt and hair, or wool. Of the remainder, perhaps, on the average, only about as much will be used as human food as will not be consumed of the nitrogenous substance of the bones of the carcass.

With the larger percentage of nitrogenous substance and the less percentage of fat, the collective offal parts have invariably a less percentage of total dry substance, and therefore a larger proportion of water, than the collective carcass parts.

Composition of the Entire Bodies.

It is, of course, the composition of the *entire bodies* of the fattened animals which represents that of the gross product of the feeding process. It is this, therefore, that is of the most interest to the Farmer; and it is this which has to be considered in relation to the constituents of food expended in its production. Table XII. shows the percentage of *mineral matter*, of *dry nitrogenous compounds*, of *fat*, of *total dry substance*, and of *water*, in the *entire body* of each of the ten animals analysed. It at the same time shows how much of the total amount of each constituent was contained in the carcass, and how much in the offal parts.

The Mineral Matter.—There is a marked diminution in the percentage of mineral matter in the entire body as the animal matures.

It may be judged from the figures that from 3½ to 4 per cent. (according to breed and condition) of the fasted live-weight of fattened *calves* and *oxen* will be mineral matter. Excluding the adventitious matter of the wool, the proportion of mineral matter in fattened *lambs* and *sheep* would probably be often as little as 2½, and seldom more than 3 per cent. In *pigs* the proportion of mineral matter is still less. In a well-fattened pig of good breed it may amount to only 1½ per cent., or even less, of its standing live-weight. In a young *un*fattened pig there were found 2·67 per cent. of mineral matter; but in an animal of worse breed, or in a leaner condition still, it may be judged that there might be 3 per cent.

As an average estimate of the *mineral matter* in *store* animals sold off or brought on the farm, we should be disposed to adopt 4½ to 5 per cent. of the live-weight of oxen, 3 to 3½ per cent. for sheep, and 2½ to 3 per cent. for pigs.

As a general average estimate, it may be assumed that 35 to 40 per cent. of the mineral matter of the entire bodies will be phosphoric acid, and 5 to 6 per cent. potash.

The Nitrogenous Compounds.—Of total nitrogenous compounds, as well as total mineral matter, oxen seem to contain (in parallel conditions) rather more than sheep, and sheep rather more than pigs.

Including bones, pelt, hair or wool, and internal organs, the entire body of a fat calf contained about $15\frac{1}{3}$, of a moderately-fat ox $14\frac{1}{2}$, of a fat lamb $12\frac{1}{3}$, of a fat sheep $12\frac{1}{3}$, of a very fat one 11, and of a moderately-fattened pig about the same amount, namely, 10·9 per cent. of dry nitrogenous substance.

The store animals contained from 2 to 3 per cent. more of total dry nitrogenous substance than the moderately-fat ones.

The Fat.—The fat constitutes by far the most prominent item in the dry or solid matter of the fed and slaughtered animals.

Of the animals not ripe for the butcher, the entire body of the half-fat ox contained $18\frac{3}{4}$ per cent. of dry fat, or more than of dry nitrogenous substance, and nearly as much as of nitrogenous substance and mineral matter put together. The entire body of the store sheep contained nearly 19 per cent. of fat, or more than of other solid matter, and that of the half-fat old sheep about $23\frac{1}{4}$ per cent., or more than $1\frac{1}{2}$ time as much as of dry nitrogenous substance. The store pig contained about $23\frac{1}{2}$ per cent. of fat, or about the same amount as the half-fat old sheep, but a somewhat larger proportion to the other solid matters.

Of the animals fit for the butcher, the entire body of the fat ox contained rather more, and that of the fat lamb rather less, than 30 per cent. of fat; that of the fat sheep $35\frac{1}{2}$ per cent., that of the very fat sheep $45\frac{2}{3}$ per cent., and that of the fat pig 42 per cent.

The body of the fat calf contained only $14\frac{1}{2}$ per cent. of fat, or less both in actual amount and in proportion to the other solid matters than that of any of the other animals analysed.

Thus, analysis shows that the *entire bodies* of some of the most important animals fed and slaughtered for human food, even when in a reputed *lean* condition, may contain more dry *fat* than dry *nitrogenous* compounds. This was the case with the half-fat ox, a store or lean young sheep, a half-fat old sheep, and a store or lean young pig. In fact, the two latter—the half-fat old sheep and the store pig—contained nearly $1\frac{3}{4}$ time as much dry fat as dry nitrogenous matter.

Of the animals ripe for the butcher, an ox contained rather more than twice as much, a moderately-fat sheep nearly three times as much, and a very fat sheep rather more than four times as much, dry fat as dry nitrogenous substance. A moderately-fat pig also contained about four times as much dry fat as dry nitrogenous substance. Even a fat lamb yielded more than twice as much. The calf alone, though professedly fattened, contained rather less fat than nitrogenous matter.

Taking the mean composition of the six animals assumed to be fit for the butcher—namely, the fat calf, the fat ox, the fat lamb, the fat sheep, the very fat sheep, and the fat pig—we have, in round numbers, 3 per cent. of mineral matter, 13 per cent. of dry nitrogenous compounds, and 33 per cent. of fat, in their fasted live-weight, = 49 per cent. total dry substance, exclusive of that of the contents of stomachs and intestines.

All the experimental evidence conspires to show that the so-called "fattening" of animals is properly so designated. Even "*lean*" animals have been seen to contain more fat than nitrogenous compounds. After the feeding or fattening process, the percentage of the total dry substance of the body is considerably increased; and the fatty matter accumulates in much larger proportion than the nitrogenous compounds. It is obvious, therefore, that the *increase* of the fattening animal must contain a lower percentage of nitrogenous substance, and a higher one of both fat and total dry substance, than the entire body of the slaughtered animal. Moreover, with the comparatively small increase in the amount of bone, and the small accumulation of soft nitrogenous parts, we should expect the percentage of mineral matter also to be very small in the *increase* of the fattening animal.

IV. Estimated Composition of the Increase of Fattening Oxen, Sheep, and Pigs.

It is obvious that, provided we knew the composition of an animal when it weighed any given weight—say 100 lbs.—and again, when, after fattening, it had reached another weight—say 150 lbs.—it would be a very easy matter to calculate the actual and the percentage composition of the 50 lbs. that had been gained. The practical difficulty rests in the fact that we cannot know the exact composition of a fattened animal at the time it was put upon fattening food, or when it had reached any given previous weight. Exercising a careful judgment on the point, we have applied the composition of the respective animals analysed in the lean condition, to the known weights of numbers of animals of the same description, when assumed to be in a similar lean condition. In like manner the composition of the fat animals analysed has been applied to the weights of the same animals after being fattened.

In the manner here described, the composition of the *increase* of 98 fattening oxen, 349 fattening sheep, and 80 fattening pigs—each divided into numerous classes, according to breed, condition of maturity, or description of food—has been calculated. The composition of the increase, so calculated, together with some

collateral particulars of the feeding experiments, are recorded in the three following Tables: Table XIII. referring to oxen, Table XIV. to sheep, and Table XV. to pigs:—

TABLE XIII.—Estimated Composition of the *Increase* of Fattening BULLOCKS and HEIFERS.

[NOTE.—*Original* weight taken at the Composition of the "Half-fat Ox" analysed. *Final* weight at the Composition of the "Fat Ox" analysed.

GENERAL PARTICULARS OF THE EXPERIMENTS.						Calculated per Cent. in Increase.			
Authority.	Description of Animal.	Number of Animals.	Duration of Experiment.	Description of Fattening Food.	Increase upon 100 Original weight.	Mineral Matter (ash).	Nitrogenous Compounds (dry).	Fat (dry).	Total Dry Substance.
			wks. days.						
Mr. Templeton*	Heifers	12	18 6	Swedish turnips hay, and oat-straw.	26·0	1·05	6·51	72·5	80·0
Hon. Capt. Grey†	Bullocks	50	29¼ 0	Oilcake, bean-meal, and turnips.	30·4	1·47	7·68	66·3	75·4
Hon. Capt. Grey†	Bullocks	36	26¾ 0	Oilcake, bean-meal, and turnips.	32·4	1·62	8·10	64·1	73.8
Average—98 animals . .						1·47	7·69	66·2	75·4

* Journal of the Royal Agricultural Society of England, vol. xvi. pp. 103-109.
† Gardeners' Chronicle and Agricultural Gazette, pp. 715 and 732 (1852.)

It is obvious that the correctness of the estimates of the composition of *increase* recorded in the Tables will entirely depend upon the degree of identity of the composition of the specimen animals analysed with that of those to which the analytical data are applied in the calculations. The results must indeed be looked upon as only approximations; though we believe the data now supplied constitute the most reliable basis for estimates of this kind at present at command.

So far as *oxen* are concerned, we have taken for our estimations of the composition of *increase* the best experiments on record with which we are acquainted, that show, so far as can be judged, a progress comparable with that supposed in the change from the condition of the "half-fat" to that of the "fat-ox" analysed.

In regard to sheep and pigs, we take the data supplied by our own numerous feeding-experiments, the results of most of which, so far as the relation of gross increase in live-weight to the amount of food, or its constituents, consumed, is concerned, have already been published in full, either in this Journal or elsewhere, and of which a condensed summary is given at the commencement of this Article.

By the side of the estimates of the composition of the increase of the fattening pigs there is given, for the sake of comparison, the

TABLE XIV.—Estimated Composition of the *Increase* of Fattening SHEEP.

GENERAL PARTICULARS OF THE EXPERIMENTS.								Calculated per Cent. in Increase.			
Breed.	Number of Animals.	Duration.		Description of Fattening Food. Given in Limited Quantities.	Description of Fattening Food. Given ad libitum.	Increase upon 100 Original weight.	Per cent. Carcass in Fasted Live-weight.	Mineral matter (ash).*	Nitrogenous Compounds (dry).	Non-nitrogenous Substance (fat).	Total Dry Substance.
CLASS I.†—*Original* weight taken at the composition of the "Store Sheep" analysed. *Final* weight at the composition of the "Fat Sheep" analysed.											
		wks.	days								
Cotswolds	46	19	5	Oilcake and clover hay.	Swedish turnips.	53·1	59·6	2·14	7·34	67·5	77·0
Leicesters	40	20	0			44·0	57·2	2·01	6·34	74·2	82·5
Cross-bred wethers	40	20	0			46·8	58·0	2·06	6·70	71·8	80·6
Cross-bred ewes	40	20	0			46·6	58·6	2·05	6·67	72·0	80·7
Hants Downs	40	26	0			61·4	59·5	2·23	8·01	63·2	73·5
Sussex Downs	40	26	0			59·9	58·9	2·22	7·90	63·9	74·0
					Means	52·0	58·6	2·12	7·16	68·8	78·0
CLASS II.—*Original* weight taken at the composition of the "Fat Sheep" analysed. *Final* weight at the composition of the "Extra Fat Sheep" analysed.											
Cotswolds	6	34	6	Oilcake and clover hay.	Grass, turnips, &c. in the field.	39·5	64·1	3·13	7·86	70·0	81·0
Leicesters	7	34	4			41·0	64·6	3·13	8·02	68·7	79·9
Cross-bred wethers	8	34	4			40·2	64·8	3·09	7·95	69·3	80·4
Cross-bred ewes	8	34	4			42·1	64·3	3·10	8·07	68·5	79·6
Hants Downs	8	31	5			33·2	63·2	3·17	7·18	75·3	85·6
Sussex Downs	8	31	5			34·0	63·2	3·13	7·41	73·5	84·1
					Means	38·3	64·0	3·12	7·75	70·9	81·8
CLASS III. (SERIES 1.‡)—*Original* weight taken at the *mean* composition of the "Store" and the "Fat Sheep" analysed. *Final* weight at the composition of the "Fat Sheep" analysed.											
Hants Downs	5	13	6	Oilcake	Swedish turnips.	23·3	56·6	2·00	6·69	72·0	80·7
	5	13	6	Oats		25·8	56·5	2·12	7·21	68·5	77·8
	5	11	6	Clover chaff		27·8	53·3	2·19	7·59	66·1	75·7
					Means	25·6	55·5	2·10	7·16	68·8	78·1
CLASS IV. (SERIES 2.‡)—*Original* weight taken at the *mean* composition of the "Store" and the "Fat Sheep" analysed. *Final* weight at the composition of the "Fat Sheep" analysed.											
Hants Downs	5	19	1	Oilcake	Clover chaff.	25·1	56·6	2·10	7·08	69·4	78·5
	5	19	1	Linseed		23·6	57·5	2·10	6·71	71·6	80·3
	5	19	1	Barley		23·1	58·5	2·01	6·62	72·4	81·0
	5	19	1	Malt		20·1	59·2	1·90	5·78	77·8	85·4
					Means	23·0	57·9	2·03	6·55	72·8	81·3
CLASS V. (SERIES 4.‡)—*Original* weight taken at the composition of the "Store Sheep" *plus* two-thirds of the difference between the "Store" and "Fat Sheep" analysed. *Final* weight at the composition of the "Fat Sheep" analysed.											
Hants Downs	4	10	0	Barley (ground)	Man-golds.	15·6	58·3	2·10	6·67	71·8	80·6
	5	10	0	Malt (ground) and malt dust		16·1	57·9	2·10	6·86	70·7	79·7
	4	10	0	Barley (ground and steeped).		18·9	57·1	2·17	7·68	65·4	75·3
	4	10	0	Malt (ground and steeped), and malt dust		13·9	58·6	1·92	5·90	76·1	84·2
	5	10	0	Malt (ground) and malt dust		16·2	55·9	2·04	6·94	70·5	79·4
					Means	16·1	57·6	2·07	6·81	70·9	79·8
					General Means of all			2·34	7·13	70·4	79·9

* The amounts of "mineral matter" are too high, owing to the adventitious matters retained by the wool; the numbers for "Class II." will be most excessive from this cause; see text, pp. 459, 460, and 467.

† Journal of the Royal Agricultural Society of England, vol. xii. part 2; vol. xiii. part 1; and vol. xvi. part 1.

‡ Ibid. vol. x. part 1.

TABLE XV.—Estimated Composition of the *Increase* of Fattening PIGS.

[NOTE.—In all cases *Original* weight taken at the Composition of the "Store Pig" analysed. *Final* weight taken at the Composition of the "Fat Pig" analysed.]

GENERAL PARTICULARS OF THE EXPERIMENTS.							Calculated per Cent. in Increase.			
Pens.	Number of Animals.	Duration.	Description of Fattening Food. Given in Limited Quantity.	Description of Fattening Food. Given ad libitum.	Increase upon 100 Original weight.	Per Cent. Carcass in Fasted Live-weight.	Mineral Matter (ash).*	Nitrogenous Compounds (dry).	Non-nitrogenous Substance (fat).	Total Dry Substance.
			The "Store" and "Fat Pig" actually analysed.							
		wks. days.								
	1	,,				75·7				
	1	10 0	Mixture of bran 1, bean and lentil meal 2, and barley-meal 3 parts, ad libitum . . .		85·4	82·8	0·53†	7·76†	63·1†	71·4†
			SERIES I.‡							
1	3	8 0	None	Bean and lentil meal	68·9	81·9	0·16	6·73	69·6	76·5
2	3		Indian-meal	Bean and lentil meal	79·6	83·0	0·36	7·29	65·9	73·6
4	3		Indian-meal and bran . .	Bean and lentil meal	59·0	82·2	—0·07	6·03	74·2	80·1
5	3		None	Indian-meal	51·3	85·4	—0·36	5·29	79·0	84·0
6	3		Bean and lentil meal . .	Indian-meal	67·0	84·4	0·10	6·61	70·4	77·1
7	3		Bran	Indian-meal	74·5	83·7	0·26	7·02	67·5	74·9
8	3		Bean and lentil meal and bran	Indian-meal	80·3	83·5	0·37	7·32	65·7	73·4
12	3		Bean and lentil meal, Indian-meal and bran, each ad libitum		59·7	83·9	—0·04	6·05	73·9	79·8
	24		Means		67·5	83·5	0·09	6·54	70·8	77·4
			SERIES II.‡							
1	3	8 0	None	Bean and lentil meal.	45·0		—0·66	4·56	84·1	88·0
2	3		Barley-meal	Bean and lentil meal.	63·7		0·03	6·37	71·9	78·3
3	3		Bran	Bean and lentil meal.	59·7		—0·04	6·07	73·8	79·8
4	3		Barley-meal and bran . .	Bean and lentil meal.	55·7		—0·17	5·71	76·1	81·7
5	3		None	Barley-meal	64·9		0·07	6·46	71·6	77·8
6	3		Bean and lentil meal . .	Barley-meal	58·6		—0·08	5·98	74·4	80·3
7	3		Bran	Barley-meal	65·0		0·07	6·46	71·3	77·8
8	3		Bean and lentil meal and bran	Barley-meal	44·6		—0·64	4·49	84·1	88·2
9 & 10	6		Mixture of bran 1, barley-meal 2, and bean and lentil meal 3 parts, ad libitum . .		63·7		0·06	6·38	71·8	78·3
11 & 12	6		Mixture of bran 1, bean and lentil meal 2, and barley-meal 3 parts, ad libitum . .		74·6		0·27	7·05	67·4	74·8
	36		Means		61·1		—0·10	5·95	74·6	80·5
			SERIES III.‡							
1	4	8 0	Dried cod-fish	Bran and Indian-meal (equal parts.)	51·1	84·6	—0·37	5·26	79·1	84·1
2	4		Dried cod-fish	Indian-meal	60·1	87·3	—0·05	6·12	73·6	79·7
	8		Means		55·7	86·0	—0·21	5·69	76·3	81·8
			SERIES IV.§							
1	3	10 0	Lentil meal and bean . .	Sugar . . .	86·4	83·1	0·48	7·53	64·1	72·1
2	3		Lentil meal and bean	Starch . . .	87·0	80·1	0·48	7·58	63·9	72·0
3	3		Lentil meal and bean	Sugar and starch	96·8	81·7	0·58	7·98	62·0	70·6
4	3		Lentils, bran, sugar, starch, each ad libitum		106·8	80·8	0·70	8·17	59·9	68·8
	12		Means		94·3	81·4	0·56	7·81	62·5	70·9
			General Means				0·06	6·44	71·5	78·0

* The amount of mineral matter is probably in many cases too low, see text, p. 468.

† These figures are somewhat corrected from those given in the Report of the British Association for the Advancement of Science for 1852, where the Composition of the Increase of this analysed "Fat Pig" is given as follows:—Mineral Matter 0·43, Nitrogen 1·33 (equal about 8·38 Nitrogenous Compounds), 63·4 Fat, and 71·8 Total Dry Substance.

‡ For further particulars of the experiments, see Journal of the Royal Agricultural Society of England, vol. xiv. part 2.

§ For further particulars of the experiments, see Report of the British Association for the Advancement of Science for 1854.

the estimated composition of the increase from the store to the fat condition of the single pig that was put up to fatten when it was, as nearly as could be judged, in a parallel state to the one analysed as "store," and was itself afterwards analysed as "fat," and whose composition, together with that of the store animal, provides the data for application to the other cases.

Noticing first the *composition of the increase* of the *oxen*, it is probable that the estimate is the most nearly correct for the 36 animals that were under experiment for 26¾ weeks, and whose proportion of increase upon 100 original weight was the highest. The mean of all the 98 animals gives, for the composition of the increase, 75·4 per cent. of total dry substance, of which 66·2 were fat, 7·69 dry nitrogenous compounds, and 1·47 mineral matter. These figures may perhaps be taken as pretty nearly representing the average composition of the increase, over the concluding period of half a year or more, of animals fed on good fattening food, and brought at last to a fair condition of maturity and fatness. In passing a judgment as to the probable direction of their error, we should say that the fat and total dry matter may possibly be stated somewhat too high, and the nitrogenous matter somewhat too low.

An examination of Table XIV., relating to sheep, will show that the several "Classes" of animals were fed upon different foods, and for different periods of time, and gave accordingly different proportions of increase upon 100 original weight, and also different proportions of carcass in fasted live-weight. These points are of course taken into consideration in adopting, from the data relating to the animals actually analysed, a composition for the original and final weights respectively of the different Classes.

Thus, in Class I., large numbers of animals were fed for a considerable period of time from a fair *store* to a fair *fat* condition. Accordingly the composition of the analysed "store sheep" is applied to the original weights, and that of the analysed "fat sheep" to the final weights.

In Class II. the animals were fed from a *fat* to a *very fat* condition—in fact, to the condition of what is called "Christmas mutton." In these cases, therefore, the original weights are calculated at the composition of "fat sheep," and the final weights at that of the "extra-fat sheep" analysed.

In Classes III. and IV. the animals were taken in a partially fattened condition, and fed to that of moderate fatness. In the case of Class III. the period of the feeding experiment was comparatively short; and in that of Class IV. the food was not well adapted for fattening. Hence in these cases the proportion of increase upon the original weights averaged only about half as

much as in Class I. Having regard to these circumstances, the composition of the original weights of the sheep of Classes III. and IV. is taken at the *mean* between that of the "store" and that of the "fat sheep" analysed; and that of their final weights at that of the "fat sheep" itself.

From considerations of a similar nature, in Class V., the original weights are taken at a composition *two-thirds* advanced from that of the "store" to that of the "fat sheep" analysed. The final weights are taken at the composition of the analysed "fat sheep."

The percentage of *carcass in fasted live-weight*, as given in the Table, shows pretty well the comparative *final* condition of the respective lots; and this was obviously not widely different in Classes I., III., IV., and V.

It must not be supposed that the differences which the figures show in the estimated composition of the increase of the different sets of animals within one and the same Class, may really be taken as representing the variations in composition attributable to the variations in breed, food, &c. All that can be claimed is, that the results as a whole give the best indications of the composition of the increase of fattening sheep at present at command, and that they pretty fairly represent the differences between Class and Class.

From the figures in the Table, it would appear that the increase of the fattening sheep contained from 2 to 3 per cent. of *mineral matter*. Either of these estimates is, however, undoubtedly too high. The error is due to the fact that there was a quantity of dirt in the wool, which added considerably to the weight of its ash; and it happened to be the greater in that of the fatter animals. Excluding altogether from the calculations the ash of the wool, the percentage of mineral matter in the increase of these fattening sheep would appear to be certainly under 2, and sometimes under 1½, per cent.

In the increase of the fattening *sheep* the average estimate of *nitrogenous compounds* is 7·13, of fat 70·4, and of total dry substance 79·9 per cent. Thus the calculations show a rather less percentage of nitrogenous compounds, and a rather higher one of both fat and total dry substance, in the increase of the fattening sheep than in that of the oxen. It would be expected that, under comparable conditions, such would be the case.

The composition of the increase from the store to the fat condition of the analysed fat pig (see top of Table XV.) shows 0·53 per cent. mineral matter, 7·76 per cent. nitrogenous compounds, 63·1 per cent. of fat, and in all 71·4 per cent. of total dry substance.

Against these numbers, which undoubtedly represent the truth very closely for the particular animal to which they refer, the

average of all the other estimates gives 0·06 per cent. mineral matter, 6·44 per cent. nitrogenous compounds, 71·5 per cent. of fat, and 78·0 per cent. of total dry substance—that is, less mineral matter and nitrogenous compounds, and several per cent. more fat and total dry substance than in the case of the single analysed fat pig. Most of the animals, the composition of whose increase is thus estimated, were, in fact, in a somewhat further advanced condition than the single animal, both at the commencement (as was shown by the original weights) and at the conclusion, as is seen by the percentages of carcass in fasted live-weight recorded in the Table.

According to the figures in the Table, the percentage of *mineral matter* in the increase of the pigs was in all cases very small; in fact, in many cases, there was *apparently* a loss of mineral matter during the fattening process. From the known tendency of the pig to fatten rather than to grow, when liberally fed with the current fattening food-stuffs, we should expect that the bony framework—the chief storehouse of mineral matter—would develop less in its case than in that of either fattening sheep or oxen. Still it is not safe to assume, upon the evidence of the analysis of only two animals, that there would frequently be an actual reduction of the total mineral matter of the body during the fattening period. The more probable alternative is, that for the purpose of the application of their composition to the cases in the Table, the analysed fat pig was, compared with the analysed leaner one, of somewhat too light a frame.

The following Table shows, at one view, the *mean* results of the numerous estimates of the composition of the increase whilst fattening, for each of the three descriptions of animal—oxen, sheep, and pigs:—

TABLE XVI.

CASES.	Estimated per cent. in Increase whilst Fattening.			
	Mineral Matter (Ash).	Nitrogenous Compounds (Dry).	Fat.	Total Dry Substance.
Average—98 Oxen	1·47	7·69	66·2	75·4
Average—348 Sheep	2·34*	7·13	70·4	79·9
Average—80 Pigs	0·06†	6·44	71·5	78·0
The analysed Fat Pig	0·53	7·76	63·1	71·4
Mean	1·10	7·26	67·8	76·2

* Probably 0·5 per cent., or more, too high, owing to the amount of adventitious matters in the wool of the sheep analysed, particularly the fatter ones; see text, pp. 459, 460, and 467.
† Probably too low; see text above.

It may probably be estimated that the *increase* of liberally fed

oxen, over 6 months or more of the final fattening period, will consist of 70 to 75 per cent. total dry substance—of which 60 to 65 parts will be fat, 7 to 8 parts nitrogenous compounds, and about $1\frac{1}{2}$ part mineral matter.

On the same plan of calculation the final *increase* of well-fed *sheep*, fattening during several months, will probably consist of 75 per cent. or more of total dry substance—of which 65 to 70 parts will be fat, 7 to 8 parts nitrogenous compounds, and perhaps about $1\frac{3}{4}$ part mineral matter.

The *increase* of *pigs* fed for fresh pork, during the final 2 or 3 months on fattening food, may be taken at about $67\frac{1}{2}$ to $72\frac{1}{2}$ per cent. total dry substance—60 to 65 per cent. fat, $6\frac{1}{2}$ to 8 per cent. nitrogenous substance, and considerably less than 1 per cent. of mineral matter. The *increase* over the last few months of high feeding, of *pigs* fed for curing, will contain considerably higher percentages of both fat and total dry substance, and lower ones of both nitrogenous compounds and mineral matter, than that of the more moderately fattened animal.

It is obvious, that the composition of the increase of the animals will vary between that given above for the *final fattening period*, and that of the *entire bodies* (see Table XII.), according to the length of time included within the estimate, and to the age of the animal, and character of food, and the consequent character of growth. The composition of the increase during the whole course of existence will of course be very nearly represented by that of the animal at the time of being slaughtered. The latter will, however, indicate somewhat too high a percentage of nitrogenous substance, and too low a one of fat, for the total increase during life; for at the time of birth the body will probably contain a higher proportion of nitrogenous to fatty matter than at any subsequent period.

V.—Relation of the constituents stored up in the increase, to those consumed in the food, by fattening animals.

Having, in the cases of most of the sheep and of all the pigs that were experimentally fed, determined the amount of certain constituents of the food consumed to produce a given amount of increase in live-weight, and having now arrived at approximate estimates of the composition of the increase itself, we have obviously the means of calculating the proportion of the consumed constituents stored up in the increase of the fattening animal.

We shall consider—(1.) the probable amount of each of the several constituents stored up in increase, for 100 of it con-

sumed; (2.) the probable amount of each constituent stored up for 100 of total dry substance of food consumed; (3.) the relation of the amount of fat stored up, to that of the ready-formed fat in the food.

1. *Amounts of mineral matter, nitrogenous compounds, non-nitrogenous substance, and total dry substance, stored up in increase for* 100 *of each consumed.*

In Table XVII. are recorded the estimates under this head relating to sheep, and in Table XVIII. those relating to pigs.

There is evidence that, other things being equal, a highly nitrogenous food may give a tendency to a comparatively large increase in frame and flesh. At the same time, observation leads to the conclusion, that with animals fattening under ordinary conditions, this tendency will not increase in anything like a numerical proportion to the increased proportion of nitrogenous constituents, supposing these to be consumed in excessive amount. The proportion of the nitrogenous matters in the increase is probably more affected by the age and habits of the animal than by their proportion in the food—provided of course that they are not in defective amount. Hence, and owing also to the small proportion of the respective constituents of the food finally retained in the increase, any error arising from adopting the same composition for the final weights of animals fattened on very various foods, is immaterial in forming merely general and average estimates of the proportion of the consumed constituents that will be stored up in the increase.

Taking the figures in Table XVII. as they stand, the average of the numerous estimates relating to *sheep*, shows rather more than 3 per cent. of the consumed mineral matter, to be retained in the increase of the animal. Assuming the due correction on account of the extraneous matter in the ash of the wool of the sheep analysed, the result would show an average of less than 3 per cent. In Class IV. dry food alone was given, and the proportion of mineral matter to digestible organic substance in the food was very large. Hence, the proportion of the consumed mineral matter reckoned to be stored up in the increase is comparatively very small—namely, only 1·68 per cent.

Upon the whole it may be concluded, as an average estimate for sheep fattening for the butcher on a good mixed diet of dry and succulent food, that they will not carry off more, and perhaps frequently less, than 3 per cent. of the consumed mineral matter. Were it not that sheep are now generally fattened when still young and growing, the proportion retained in the increase during the period of fattening, would probably be extremely small. In fact, it can hardly be greater, on the average, than above

TABLE XVII.—Estimated Amount of certain Constituents stored up in *Increase*, for 100 of each consumed in Food, by fattening SHEEP.

GENERAL PARTICULARS OF THE EXPERIMENTS.					Amount of each class of Constituents stored up in Increase for 100 of the same consumed in Food.			
Breed.	Number of Animals.	Duration.	Description of Fattening Food. Given in Limited Quantity.	Description of Fattening Food. Given *ad libitum*.	Mineral Matter (ash).*	Nitrogenous Compounds (dry).	Non-nitrogenous Substance.	Total Dry Substance.
CLASS I.†								
		wks. days.						
Cotswolds . . .	46	19 5	Oilcake and clover chaff	Swedish turnips	3·98	4·43	11·6	9·60
Leicesters . . .	40	20 0	Oilcake and clover chaff	Swedish turnips	3·15	3·39	12·0	9·43
Cross-bred wethers	40	20 0	Oilcake and clover chaff	Swedish turnips	3·24	3·60	11·6	9·31
Cross-bred ewes .	40	20 0	Oilcake and clover chaff	Swedish turnips	3·25	3·60	11·8	9·40
Hants Downs . .	40	26 0	Oilcake and clover chaff	Swedish turnips	3·40	4·28	10·3	8·49
Sussex Downs . .	40	26 0	Oilcake and clover chaff	Swedish turnips	3·30	4·16	10·3	8·44
				Means	3·39	3·91	11·3	9·12
CLASS III. (Series 1).‡								
Hants Downs .	5	13 6	Oilcake	Swedish turnips	4·16	4·01	11·1	9·33
	5	13 6	Oats	Swedish turnips	5·73	7·07	10·0	9·45
	5	13 6	Clover chaff	Swedish turnips	3·98	7·44	9·0	8·49
				Means	4·62	6·17	10·0	9·09
CLASS IV. (Series 2).‡								
Hants Downs .	5	19 1	Oilcake	Clover chaff .	1·69	2·20	6·3	5·07
	5	19 1	Linseed	Clover chaff .	1·81	2·32	6·2	5·19
	5	19 1	Barley	Clover chaff .	1·75	2·82	5·7	5·00
	5	19 1	Malt	Clover chaff .	1·46	2·17	5·3	4·61
				Means	1·68	2·38	5·9	4·97
CLASS V. (Series 4).‡								
Hants Downs .	4	10 0	Barley (ground)	Mangolds . .	3·80	5·65	9·8	8·91
	5	10 0	Malt (ground) and malt dust	Mangolds . .	4·04	6·18	10·4	9·49
	4	10 0	Barley (ground and *steeped*) .	Mangolds . .	3·72	6·35	8·9	8·28
	4	10 0	Malt (ground and *steeped*) and malt dust . . .	Mangolds . .	2·95	4·34	9·3	8·23
	5	10 0	Malt (ground) and malt dust	Mangolds . .	3·46	5·46	9·1	8·25
				Means	3·59	5·60	9·5	8·63
				Means of all . .	3·27	4·41	9·4	8·06

* The amounts of "*mineral matter*" are too high, owing to the adventitious matters retained by the wool; see text, pp. 459, 460, 467, and 470.

† For further particulars of the Experiments, see Journal Royal Agricultural Society of England, vol. xii., part 2; vol. xiii., part 1; and vol. xvi., part 1; and Report of the British Association for the Advancement of Science for 1852.

‡ For further particulars of the Experiments, see Journal Royal Agricultural Society of England, vol. x., part 1; and Report of the British Association for the Advancement of Science for 1852.

TABLE XVIII.—Estimated Amount of certain constituents stored up in *Increase*, for 100 of each consumed in Food, by fattening PIGS.

GENERAL PARTICULARS OF THE EXPERIMENTS.					Amount of each class of Constituents stored up in Increase for 100 of the same consumed in Food.				
Pens.	Number of Animals.	Duration.	Description of Fattening Food: Given in Limited Quantities.	Description of Fattening Food: Given ad libitum.	Mineral Matter (ash).*	Nitrogenous Compounds (dry).	Non-nitrogenous Substance.	Total Dry Substance.	Fat.
THE ANALYSED "FAT PIG." †									
	1	wks. days. 10 0	Mixture of bran 1, bean and lentil meal 2, and barley-meal 3 parts, ad libitum.		2·66	7·76	17·6	14·9	405
SERIES I.‡									
1	3	8 0	None	Bean and lentil meal	0·68	4·88	25·3	17·5	621
2	3	8 0	Indian-meal	Bean and lentil meal	1·86	6·39	23·7	17·9	477
4	3	8 0	Indian-meal and bran	Bean and lentil meal	−0·33	5·02	21·1	16·1	362
5	3	8 0	None	Indian-meal	−2·09	9·28	20·9	18·6	300
6	3	8 0	Bean and lentil meal	Indian-meal	0·99	9·18	20·9	18·4	324
7	3	8 0	Bran	Indian-meal	2·35	12·10	20·3	18·7	300
8	3	8 0	Bean and lentil meal and bran	Indian-meal	2·71	10·03	21·3	18·5	307
12	3	8 0	Bean and lentil meal, Indian-meal, and bran, each ad libitum		−0·22	5·65	21·1	16·8	362
				Means	0·74	7·82	21·8	17·8	382
SERIES II.‡									
1	3	8 0	None	Bean and lentil meal	−3·20	3·12	26·5	18·2	801
2	3	8 0	Barley-meal	Bean and lentil meal	0·16	4·65	19·2	14·7	575
3	3	8 0	Bran	Bean and lentil meal	−0·16	3·99	21·2	15·2	547
4	3	8 0	Barley-meal and bran	Bean and lentil meal	−0·75	4·57	20·1	15·6	514
5	3	8 0	None	Barley-meal	0·56	10·09	18·5	16·9	574
6	3	8 0	Bean and lentil meal	Barley-meal	−0·53	6·57	21·1	17·5	620
7	3	8 0	Bran	Barley-meal	0·49	9·79	18·9	16·9	506
8	3	8 0	Bean and lentil meal and bran	Barley-meal	−4·33	4·49	22·7	18·0	578
9 & 10	6	8 0	Mixture of bran 1, barley-meal 2, and bean and lentil meal 3 parts, ad libitum		0·27	5·65	20·4	16·1	495
11 & 12	6	8 0	Mixture of bran 1, bean and lentil meal 2, and barley-meal 3 parts, ad libitum		1·58	8·10	21·1	17·6	515
				Means	−0·59	6·10	21·0	16·7	572
SERIES III.‡									
1	4	8 0	Dried cod-fish	Bran and Indian-meal (equal parts)	−1·06	5·06	24·3	18·1	315
2	4	8 0	Dried cod-fish	Indian-meal	−0·26	8·16	25·6	20·9	352
				Means	−0·66	6·61	24·9	19·5	333
SERIES IV.§									
1	3	10 0	Lentil meal and bran	Sugar	3·07	9·30	19·4	16·9	..
2	3	10 0	Lentil meal and bran	Starch	3·18	9·36	19·4	16·9	..
3	3	10 0	Lentil meal and bran	Sugar and starch	4·06	10·78	17·7	16·1	..
4	3	10 0	Lentils, bran, sugar, starch, each ad libitum		4·80	9·96	18·7	16·5	..
				Means	3·78	9·85	18·8	16·6	..
				Means of all	0·58	7·34	21·2	17·3	472

* The amount of mineral matter is probably in many cases too low; see text, pp. 468 and 474.

† For further particulars of the Experiment see Report of the British Association for the Advancement of Science for 1852.

‡ For further particulars of the Experiments see Journal of the Royal Agricultural Society of England, vol. xiv. part 2.

§ For further particulars of the Experiments, see Report of the British Association for the Advancement of Science for 1854.

above supposed, during the whole existence of the animal; that is, including the previous, as well as the fattening period. The proportion of the amount consumed that will be retained in the increase, will, however, depend much more upon the relation of the mineral matter to the digestible and available organic substance of the food, than upon any other circumstance.

At any rate, the proportion of the mineral matter consumed in the food by either store or fattened sheep, which is sent off the farm in their bodies, is comparatively small. From the percentage in the *entire bodies* of the animals analysed in the different conditions, or from the estimates of the amount in the *increase* of fattening sheep, the annual loss to the farm of mineral matter from the sale of known weights of such animals, admits of easy calculation.

Of the *nitrogenous compounds* consumed by the fattening sheep, the average of the estimates shows less than 5 per cent. to be retained in their increase. With a liberal mixed diet of succulent roots and dry food, it is probable, that when the latter consists chiefly of pulse, oilcake, or other highly nitrogenous matters, the proportion of the consumed nitrogen which will be carried off in the increase of the animal, will be less than 5, and perhaps even less than 4 per cent. On the other hand, when the dry food consists chiefly of cereal grain or other matters containing a comparatively low per-cent. of nitrogen, it is probable that more than 5 per cent. of the consumed nitrogen will be carried off in the increase. On either supposition the proportion of the total nitrogen consumed by the fattening sheep, that will be expired, perspired, or voided, will be considerably more than 90 per cent., and it may be more than 95 per cent.

For 100 parts of *non*-nitrogenous substance consumed in food by the fattening sheep, it is estimated that there were on the average (excluding Class IV.), about 10 parts stored up in their increase—of course in the form of *fat itself*.

For 100 of *total dry substance* in the food of the sheep, about 8 or 9 parts of dry increase appear to have been stored up.

The dry substance of the food of sheep contains a much larger proportion of indigestible woody fibre than does that of pigs. There is, therefore, a larger proportion of the dry substance of the food of sheep necessarily at once effete.

Turning to the estimates relating to pigs (see Table XVIII.), it would appear that there is probably fully twice as much dry substance stored up in their increase for 100 consumed in their fattening food, as in the case of sheep. The average of all the estimates relating to pigs shows 17·3 parts of dry increase stored up for 100 of dry substance of food consumed, against about 15 parts in the case of the single analysed fat pig.

For 100 of *non*-nitrogenous constituents of food, the pigs seem to have stored up 20 or more of fat, whilst the sheep yielded only half that proportion.

For 100 of *nitrogenous* compounds consumed by the pigs there was, according to the estimates, on the average about $1\frac{1}{2}$ time as much stored up in the increase as in the case of sheep. Not that the increase of the fattening pig contains a larger proportion of nitrogen than that of the sheep—indeed it is more likely to contain less; but a larger proportion of the total dry substance of the food of the pig is digestible and available for increase, and accordingly, as already noticed, a given amount of it yields a much larger proportion of total dry increase; and with this, a larger actual amount of nitrogenous increase.

The average of the estimates for the pigs shows 7·34 per cent. of the consumed nitrogen to be stored up in the increase, against 7·76 per cent. in the case of the analysed fat pig. The greater the proportion of pulse, or other highly nitrogenous matters in the fattening food, the smaller will be the *proportion* of the whole consumed nitrogen, that will be stored up in the increase. On the other hand, the larger the proportion of cereal grain with its comparatively low percentage of nitrogen, the larger will be the *proportion* of the whole nitrogen consumed that will be carried off in the increase. The evidence at command leads to the conclusion, that there will be almost uniformly less than 10 per cent., and sometimes as little as 6 per cent., of the nitrogen of the food of the fattening pig carried off in its increase.

It has already been pointed out how small, in all probability, is the percentage of *mineral matter* in the increase of the rapidly-fattening pig. Reasons were given, however, for supposing that our estimates indicated a lower amount than really was the case. There is little use, therefore, in examining at all closely results that are based upon admittedly doubtful estimates. Moreover, as the mineral matter in the food varies very much in its proportion to those constituents which chiefly rule the amount and the character of the increase, the *proportion* of the mineral matter consumed by the fattening pig (as well as by other animals) which will be stored up in the increase, will be much more variable than that of the other constituents. It may be safely stated, however, that in the case of fattening pigs, the proportion of the consumed mineral matter which will not be reclaimed in the manure is almost immaterial. The amount that will be lost to the manure in the entire bodies of the animals sold is a matter of easy calculation from the data recorded in Table XII.

For every 100 parts of *ready-formed fatty matter* in the food, there were probably, on the average of the experiments with pigs, 400 to 500 parts of fat stored up in the increase of the

animals. It is obvious, therefore, that there was a *formation* of fat in the body from some other constituent or constituents of the food. To this point we shall recur presently.

2. *Amounts of Mineral Matter, Nitrogenous Compounds, Fat, and total Dry Substance stored up in Increase—and of matter expired, perspired, or voided—for* 100 *of total dry substance consumed in food.*

The results under this head are given in Table XIX. for the different sets of *sheep*, and in Table XX. for the different sets of *pigs*.

It has been already seen that, in the case of the sheep, there was probably an average of about 9 parts dry substance fixed in increase for 100 of dry substance consumed in the fattening food. Taking the cases in which the food was of the most usual description, Table XIX. shows, that with about 9 parts total dry increase, about 8 were non-nitrogenous substance—that is, *fat*. It results that for 100 total dry substance of food, there would be little more than 1 part fixed in increase as nitrogenous and mineral matters put together. Of this, making due allowance for the error in the estimates arising from the dirt in the wool, there would, on the average of the cases, be only about 0·2 of mineral matter.

Assuming 9 parts of dry increase to be the produce of 100 parts of dry substance of food, when sheep are liberally fed for the butcher, there would of course be 91 parts *expired*, *perspired*, or *voided*.

In the case of the analysed fat pig, 100 parts of dry substance of food produced 14·94 parts of dry increase. Of this, 13·2 were fat, 1·62 nitrogenous compounds, and 0·11 mineral matter. From the circumstances of this experiment it may be concluded that these figures very closely represent the actual facts.

Against these numbers, the average of all the other estimates relating to pigs—24 in number, and comprising 80 animals—indicates, 17·27 total dry increase for 100 total dry food; of which 15·81 are estimated as fat, 1·44 nitrogenous substance, and an insignificant amount mineral matter. It is admitted that the tabulated estimates of the mineral matter assimilated by sheep are too high, and that those relating to pigs are probably in error in the opposite direction.

Pigs, even when young, if put upon highly-fattening food, will grow comparatively little in frame; whilst sheep, fattened as they now generally are at a comparatively early age, will, compared with the pig, develop more of hard bony structure. The percentage of mineral matter in the carcass of the fat sheep analysed was very much higher than in that of the analysed fat pig.

In

TABLE XIX.—Estimated amount of constituents stored up in Increase, and of matter Expired, Perspired, or Voided—for 100 dry substance of food consumed, by fattening SHEEP.

GENERAL PARTICULARS OF THE EXPERIMENT.						100 Dry Matter of Food gave—				
				Description of Fattening Food.		Stored up in Increase.				Expired, Perspired, or Voided.
Breed.	Number of Animals.	Duration.		Given in Limited Quantity.	Given ad libitum.	Mineral Matter (ash).*	Nitrogenous Compounds (dry).	Non-nitrogenous Substance (fat).	Total dry Increase.	
		wks.	days.							
CLASS I.†										
Cotswolds * . . .	46	19	5	Oilcake and clover chaff .	Swedish turnips	0·26	0·92	8·41	9·60	90·40
Leicesters . . .	40	20	0			0·23	0·73	8·53	9·48	90·52
Cross-bred wethers	40	20	0			0·24	0·77	8·29	9·31	90·69
Cross-bred ewes .	40	20	0			0·24	0·78	8·39	9·41	90·59
Hants Downs . .	40	26	0			0·26	0·93	7·30	8·49	91·51
Sussex downs . .	40	26	0			0·25	0·90	7·29	8·44	91·56
Means						0·25	0·84	8·03	9·12	90·88
CLASS III. (Series 1).‡										
Hants Downs .	5	13	6	Oilcake	Swedish turnips	0·23	0·77	8·32	9·31	90·69
	5	13	6	Oats		0·25	0·88	8·32	9·45	90·55
	5	13	6	Clover chaff . .		0·24	0·85	7·40	8·49	91·51
Means						0·24	0·83	8·01	9·08	90·92
CLASS IV. (Series 2).‡										
Hants Downs .	5	19	1	Oilcake . . .	Clover chaff	0·13	0·46	4·48	5·07	94·93
	5	19	1	Linseed . . .		0·14	0·43	4·62	5·19	94·81
	5	19	1	Barley		0·12	0·41	4·47	5·00	95·00
	5	19	1	Malt		0·10	0·31	4·20	4·61	95·39
Means						0·12	0·40	4·44	4·97	95·03
CLASS V. (Series 4).‡										
Hants Downs .	4	10	0	Barley (ground) .	Mangolds	0·24	0·74	7·93	8·91	91·09
	5	10	0	Malt (ground) and malt dust		0·25	0·82	8·42	9·49	90·51
	4	10	0	Barley (ground and steeped).		0·24	0·84	7·20	8·28	91·72
	4	10	0	Malt (ground and steeped) and malt dust		0·19	0·58	7·45	8·23	91·77
	5	10	0	Malt (ground) and malt dust		0·21	0·72	7·33	8·25	91·75
Means						0·23	0·74	7·66	8·63	91·37
Means of all						0·21	0·72	7·13	8·06	91·94

* The estimated amounts of "*mineral matter*" are too high, owing to the adventitious matter retained by the wool; see text, pp. 459, 460, 467, 470, 475, and 478.

† For further particulars of the Experiments, see Journal of the Royal Agricultural Society of England, vol. xii. part 2; vol. xiii. part 1; and vol. xvi. part 1; and Report of the British Association for the Advancement of Science for 1852.

‡ For further particulars of the Experiments, see Journal of the Royal Agricultural Society of England, vol. x. part 1; and Report of the British Association for the Advancement of Science for 1852.

TABLE XX.—Estimated amount of constituents stored up in Increase, and of matter Expired, Perspired, or Voided—for 100 dry substance of food consumed, by fattening PIGS.

GENERAL PARTICULARS OF THE EXPERIMENTS.					100 Dry Matter of Food gave—				
			Description of Fattening Food.		Stored up in Increase.				
Pens.	Number of Animals.	Duration.	Given in Limited Quantity.	Given ad libitum.	Mineral Matter (ash).*	Nitrogenous Compounds (dry).	Non-nitrogenous Substance (fat).	Total Dry Increase.	Expired, Perspired, or Voided.
THE ANALYSED "FAT PIG."†									
	1	wks. days. 10 0	Mixture of bran 1, bean and lentil meal 2, and barley-meal 3 parts; ad libitum		0·11	1·62	13·20	14·94	85·06
SERIES I.‡									
1	3	8 0	None	Bean and lentil-meal	0·04	1·54	15·93	17·51	82·49
2	3	8 0	Indian meal	Bean and lentil-meal	0·09	1·77	16·00	17·86	82·14
4	3	8 0	Indian meal and bran	Bean and lentil-meal	—0·01	1·21	14·95	16·15	83·85
5	3	8 0	None	Indian meal	—0·08	1·17	17·48	18·58	81·42
6	3	8 0	Bean and lentil-meal	Indian meal	0·02	1·57	16·76	18·35	81·65
7	3	8 0	Bran	Indian meal	0·07	1·75	16·83	18·68	81·32
8	3	8 0	Bean and lentil meal and bran	Indian meal	0·09	1·85	16·59	18·53	81·47
12	3	8 0	Bean and lentil meal, Indian-meal, and bran, each ad libitum		—0·01	1·27	15·59	16·84	83·16
				Mean	0·03	1·51	16·27	17·81	82·19
SERIES II.‡									
1	3	8 0	None	Bean and lentil-meal	—0·13	0·94	17·37	18·18	81·82
2	3	8 0	Barley-meal	Bean and lentil-meal	0·01	1·19	13·49	14·69	85·31
3	3	8 0	Bran	Bean and lentil-meal	—0·01	1·15	14·06	15·20	84·80
4	3	8 0	Barley-meal and bran	Bean and lentil-meal	—0·03	1·09	14·50	15·56	84·44
5	3	8 0	None	Barley-meal	0·02	1·40	15·45	16·87	83·13
6	3	8 0	Bean and lentil meal	Barley-meal	—0·02	1·30	16·21	17·49	82·51
7	3	8 0	Bran	Barley-meal	0·01	1·40	15·50	16·91	83·09
8	3	8 0	Bean and lentil meal and bran	Barley-meal	—0·13	0·91	17·18	17·96	82·04
9 & 10	6	8 0	Mixture of bran 1, barley-meal 2, and bean and lentil meal 3 parts; ad libitum		0·01	1·31	14·77	16·11	83·89
11 & 12	6	8 0	Mixture of bran 1, bean and lentil meal 2, and barley-meal 3 parts; ad libitum		0·06	1·66	15·88	17·00	82·40
				Means	—0·02	1·23	15·44	16·66	83·34
SERIES III.‡									
1	4	8 0	Dried cod-fish	Bran and Indian meal (equal parts)	—0·08	1·13	17·05	18·12	81·88
2	4	8 0	Dried cod-fish	Indian meal	—0·01	1·60	19·27	20·86	79·14
				Means	—0·04	1·36	18·16	19·49	80·51
SERIES IV. §									
1	3	10 0	Lentil-meal and bran	Sugar	0·11	1·76	15·01	16·88	83·12
2	3	10 0	Lentil-meal and bran	Starch	0·11	1·78	15·04	16·94	83·06
3	3	10 0	Lentil-meal and bran	Sugar and starch	0·13	1·82	14·13	16·08	83·92
4	3	10 0	Lentils, bran, sugar, starch; each ad libitum		0·19	1·96	14·36	16·50	83·50
				Means	0·13	1·83	14·63	16·60	83·40
				Means of all	0·02	1·44	15·81	17·27	82·73

* The amount of mineral matter is probably in many cases too low; see text, pp. 468, 474, 475, and 478.
† For further particulars of the Experiment, see Report of the British Association for the Advancement of Science for 1852.
‡ For further particulars of the Experiments, see Journal of the Royal Agricultural Society of England, vol. xiv. part 2.
§ For further particulars of the Experiments, see Report of the British Association for the Advancement of Science for 1854.

In the case of both the oxen and the sheep, there is a striking uniformity in the proportion of the mineral to the nitrogenous matters of growth. In the pig, not only is the actual amount of mineral matter much less, but its proportion to the nitrogenous matters seems to decrease as the animals fatten. Thus, the proportion of mineral matter to 1 of nitrogenous substance was, in the carcass of the lean ox, 0·31, of the fat ox 0·30, of the store-sheep 0·30, of the fat sheep 0·30, and of the very fat sheep 0·30. On the other hand, in the carcass of the store-pig, the proportion of mineral matter to 1 of nitrogenous substance was 0·183, and in that of the fat pig only 0·133. It would appear, therefore, that the amount of mineral matter in the increase of the fattening pig will be less than in that of the sheep, both in proportion to the total increase itself, and to the coincidently accumulated nitrogenous compounds.

When it is remembered that the usual fattening food of the pig consists largely of ripened seeds, containing comparatively little indigestible woody fibre, or immatured vegetable products, it will not appear surprising that 100 parts of the dry substance of its food should yield much more dry animal increase than 100 parts of that of the sheep. In the case of the sheep it was assumed (as the average of the cases wherein the food was of the most favourable kinds), that for 100 parts of dry substance consumed, only about 9 parts of dry increase were produced, and that 91 parts were in some form expired, perspired, or voided. Calculated in the same way, there were, in the case of the analysed fat pig, only 85 per cent. of the dry substance of the food expired, perspired, or voided. And, taking the average of the 24 lots of pigs, comprising 80 animals, similar calculations show only 82·7 per cent. of the dry substance of the food expired, perspired, or voided.

The relation of the ultimate elements in the total dry matter assimilated is, of course, very different from that in the total matters given off in the various ways from the system. It is not within the scope and object of the present paper to consider the composition of the matters collectively given out from the body, and still less to determine the proportions, respectively, expired by the lungs, perspired by the skin, or voided in the liquid and solid excrements. Some illustration of the difference in ultimate composition, between the dry substance of the food, and that of the increase produced from it, will be brought to light in what now follows.

3. *Relation of the Fat stored up in the Increase, to the ready-formed Fat, and other constituents, consumed in the food, &c.*

In the majority of the experiments with the pigs, the amount of *ready-formed* fatty matter in the food was determined. Com-

paring this with the estimated amount of fat in the increase, it appears (see Table XVIII.), that there were, on the average, 4 to 5 times as much fat stored up as there was so supplied in the food. In the case of the analysed fat pig, the result was obtained in as direct a manner as the nature of the question admits of; and it appeared that 405 parts of fat were stored up, for 100 consumed in food. The average of the other experiments shows 472 parts of fat in increase for 100 ready-formed in food.

It seems not improbable that fat may be *produced* in the animal body by the aid of the products of transformation within it of *nitrogenous* compounds. But it is probable, that at least the main source of the produced fat is the *non*-nitrogenous constituents of the food. Of these, particularly in the fattening food of the pig, the most prominent item is *starch*. We adopt this substance, therefore, as the basis of the illustrations of the probable amount of the constituents of the food involved in the formation of the *produced* fat, in the experiments in question.

For practical purposes it may be assumed, that $2\frac{1}{2}$ parts of starch will be required for the formation of 1 part of the mixed fats of the animal body, when these have their source in that substance. If fat be formed from *nitrogenous* compounds, a *less* amount of the dry substance of the food will then be required for the formation of a given amount of fat, than when it is produced from starch. If *sugar* be the source of the fat, a slightly *larger* quantity than of starch will be required. Of the *pectine* bodies, again, which enter so largely into the roots that frequently constitute a large proportion of the fattening food of oxen and sheep, the quantity required would be still more than of sugar.

Table XXI. shows the estimated amount of fat stored up in increase for 100 dry matter of food, the amount of ready-formed fat in the food, the amount of fat that must have been *produced* from other compounds, and the amount of starch required if the produced fat were formed from it, in the cases of the numerous experiments with pig.

It is estimated that, in the case of the single analysed fat pig, 100 dry substance of the fattening food gave 13·2 parts of fat in increase. Of this, only 3·26 parts could have been derived from ready-formed fat in the food, even supposing the whole so supplied had been taken up. At least 9·94 parts must, therefore, have been formed in the body of the animal from some other constituent or constituents. If the constituent in question were *starch*, it would require (at the rate of $2\frac{1}{2}$ parts starch for 1 of fat) 24·8 parts of that substance for the formation of

TABLE XXI.—Showing the amount of Fat stored up in the Increase of Fattening Pigs for 100 of Dry Matter of Food consumed, the proportion of Fat already formed in the Food, the amount of Fat that must have been *produced* from other compounds, and the amount of Starch that would be required if the produced Fat were formed from it.

GENERAL PARTICULARS OF THE EXPERIMENTS.					For 100 Dry Matter of Food.			
Pens.	Number of Animals.	Duration	Description of Fattening Food. Given in Limited Quantity.	Description of Fattening Food. Given ad libitum.	Total Fat in Increase.	Fat already formed in the Food.	Fat produced from Starch, &c.	Starch required for the produced Fat.
THE ANALYSED "FAT PIG."*								
	1	wks. days. 10 0	Mixture of bran 1, bean and lentil meal 2, and barley-meal 3 parts; ad libitum		13·20	3·26	9·94	24·85
SERIES I.†								
1	3	8 0	None	Bean and lentil meal	15·93	2·89	13·04	32·60
2	5	8 0	Indian-meal	Bean and lentil meal	16·00	3·66	12·34	30·85
4	3	8 0	Indian-meal and bran	Bean and lentil meal	14·95	4·59	10·36	25·90
5	3	8 0	None	Indian-meal	17·48	6·15	11·33	28·32
6	3	8 0	Bean and lentil meal	Indian-meal	16·76	5·43	11·33	28·32
7	3	8 0	Bran	Indian-meal	16·83	6·31	10·52	26·30
8	3	8 0	Bean and lentil meal, and bran	Indian-meal	16·59	5·64	10·95	27·37
12	3	8 0	Bean and lentil meal, Indian-meal, and bran, each ad libitum		15·59	4·65	10·94	27·35
				Means	16·27	4·92	11·35	28·38
SERIES II.†								
1	3	8 0	None	Bean and lentil meal	17·37	2·40	14·97	37·42
2	3	8 0	Barley-meal	Bean and lentil meal	13·49	2·55	10·94	27·35
3	3	8 0	Bran	Bean and lentil meal	14·06	2·85	11·21	28·02
4	3	8 0	Barley-meal and bran	Bean and lentil meal	14·50	3·08	11·42	28·55
5	3	8 0	None	Barley-meal	15·45	2·83	12·62	31·55
6	3	8 0	Bean and lentil meal	Barley-meal	16·21	2·81	13·40	33·50
7	3	8 0	Bran	Barley-meal	15·50	3·27	12·23	30·57
8	3	8 0	Bean and lentil meal, and bran	Barley-meal	17·18	3·16	14·02	35·05
9 & 10	6	8 0	Mixture of bran 1, barley-meal 2, and bean and lentil meal 3 parts; ad libitum		14·77	2·99	11·78	29·45
11 & 12	6	8 0	Mixture of bran 1, bean and lentil meal 2, and barley-meal 3 parts; ad libitum		15·88	3·08	12·80	32·00
				Means	15·44	2·90	12·54	31·35
SERIES III.†								
1	4	8 0	Dried cod-fish	Bran and Indian-meal (equal parts	17·05	5·40	11·65	29·12
2	4	8 0	Dried cod-fish	Indian-meal	19·27	5·48	13·79	34·47
				Means	18·16	5·44	12·72	31·79
				Means of all	16·04	3·96	12·08	30·20

* For further particulars of the Experiments, see Report of the British Association for the Advancement of Science for 1852.

† For further particulars of the Experiments, see Journal of the Royal Agricultural Society of England, vol. xiv., part 2.

of the 9·94 parts of *produced* fat. There would thus be of ready-formed fat and starch, taken together, 28·11 parts out of 100 dry matter of food, directly engaged in the storing up in the body of the 13·2 parts of fat; if we add to this 1·73 parts of nitrogenous and mineral matters at the same time fixed in the increase, we have 29·84 parts out of the 100 of dry matter of food, directly contributing, in the sense supposed, to the production of only 14·94 parts of dry increase. In the particular sense here implied, therefore, only 70·16 parts out of 100 dry matter of the food would be expired, perspired, or voided, without thus directly contributing to increase, instead of 85·06 parts—which represents the difference between the 14·94 parts only of dry substance actually stored up, and 100 of dry matter of food consumed to produce it.

Following the same line of illustration with all the other experiments with pigs, the average result obtained is, that 100 dry matter of food gave 16·04 parts of fat stored up, with only 3·96 parts of ready-formed fatty matter in the food. At least 12·08 parts must, therefore, have been formed from other substances. If from starch, it would require 30·2 parts of that substance for the formation of the 12·08 parts of *produced* fat. The ready-formed fat and the starch together would amount to 34·16 parts. There were, further, 1·36 part of nitrogenous and mineral matters assimilated. In all, therefore, 35·52 parts out of 100 of gross dry matter of food contributed in this comparatively direct manner, to the formation of 17·3 parts of gross dry increase.

It will be observed that assuming starch to be the source of the produced fat, as above described, there were almost exactly 2 parts of dry substance of food thus directly engaged in contributing to the formation of 1 part of dry increase. It appears, too, that in the case of pigs fed on good fattening food, about one-third of the whole dry substance consumed may be so devoted. About two-thirds therefore will, if at all, only in a less direct manner, contribute to the production of increase. Of this a large proportion will serve, more or less directly, for respiration only, or for the supply of material for the transformations constantly going on in the body independently of any permanent increase in its solid substance; and, besides the matters voided as indigestible and necessarily effete, a quantity of digestible constituents, larger or smaller according to the character of the food, and to the excess of it consumed, will pass off unused and comparatively unchanged.

From a knowledge of the general character of the fattening food of both oxen and sheep, considered in relation to the amount of increase it yields, and to the probable composition of that increase, it may be concluded that, in their case as well as in

that of pigs, a considerable amount of fat will frequently be formed in the body from other constituents of the food. As has been seen, however, only about half as much fat, or total dry increase, is obtained from 100 of the dry substance of the fattening food of oxen and sheep, as of that of pigs. There will, in fact, be a far less proportion of the dry matter of the food of the former than of the latter animals, appropriated in the (so to speak) direct production of increase.

It appears then, that a considerable proportion of the *fat*—of which the increase of the so-called fattening animals so largely consists—may be *formed in the body from other constituents* of the food. Of the *nitrogenous* compounds, on the other hand, it is probable that frequently as little, and even less, than 5 per cent. of the whole consumed will be found finally stored up in the increase of the animal. In fact, if the animals are to store up as much as they can do of matters not containing nitrogen, a very large amount of nitrogen must pass through the body, beyond that which is finally retained in the increase.

Since it is found, that by far the larger proportion of the solid increase of the fattening animals is really *fat* itself;—since it is probable, that at least a great part of the fat stored up in the body is derived from *starch*, and other *non*-nitrogenous constituents of the food;—since so large an amount of non-nitrogenous constituents is required to meet the respiratory demands of the system;—and since the current fattening foods contain so very much more of nitrogen than is eventually retained in the increase—it can hardly excite surprise that the comparative value of foods, *as such*, does not depend upon their percentage of nitrogenous compounds. Practically—provided the amount of nitrogenous compounds be not actually deficient, which in ordinary fattening foods is seldom the case—the amount of increase is much more frequently dependent on the proportion in the food of the digestible and assimilable *non*-nitrogenous compounds, than on that of the *nitrogenous* ones. It would, in fact, be more nearly true to say, that in our current food-stuffs, the digestible and assimilable non-nitrogenous constituents are generally in relative defect, than to say that the digestible and assimilable nitrogenous compounds are so.

As, however, the *manure* from highly nitrogenous foods is the most valuable, it frequently becomes the interest of the farmer, having regard to it, to purchase and use those having the higher amounts of nitrogen.

The comparative values of food-stuffs, even *as such*, are, however, not to be unconditionally determined by the percentage of either the total nitrogenous or total non-nitrogenous constituents. The

records of the numerous ultimate analyses of foods which have been hitherto made, are, it is true, of high value and interest in a statistical point of view. But now possessing them, as the basis of certain general estimates, the next desideratum is—to examine more closely into the nature and condition of the proximate compounds of food-stuffs—to distinguish those which are digestible and assimilable from those which are not so—to determine the relative values of the comparable or mutually replaceable portions—and above all, to fix our standards of comparative value with more of reference to direct experimental evidence on the point, and to existing knowledge of the composition of animal bodies, than has been hitherto usual, or even possible.

The main conclusions from the whole inquiry may be briefly enumerated as follows:—

I.—Food and Increase.

1. Fattening oxen, fed liberally upon good food, composed of a moderate proportion of cake or corn, some hay or straw chaff, with roots or other succulent food, and well-managed, will, on the average, consume 12 to 13 lbs. of the dry substance of such mixed food, per 100 lbs. live-weight, per week; and should give 1 lb. of increase for 12 to 13 lbs. dry substance so consumed. Sheep fattening under somewhat similar circumstances (but with a less proportion of hay or straw), will consume about 15 lbs. of the dry substance of the mixed foods, per 100 lbs. live-weight, per week; and should yield over a considerable period of time, 1 part of increase in live-weight for about 9 parts of the dry substance of their food. If the food be of good quality, oxen and sheep may give a maximum amount of increase for a given amount of total dry substance of food, even provided the latter contain as much as 5 parts of total non-nitrogenous to 1 of nitrogenous compounds.

2. Pigs, fed liberally upon food composed chiefly of corn, will consume from 26 to 30 lbs. per 100 lbs. live-weight, per week, of the dry substance of such food. They should yield 1 part of increase in live-weight for 4 to 5 parts of the dry substance of the food. They may give a maximum amount of increase for a given amount of dry substance of such food, if it contain as much as 5 or even 6 parts of total non-nitrogenous to 1 of nitrogenous compounds.

[The cereal grains contain on the average rather more than 6 parts of total non-nitrogenous to 1 of nitrogenous compounds; and the leguminous seeds often not much more than 2 parts to 1.

Oilcakes and foreign corn contain rather more than six-sevenths, and home-grown corn, hay, &c., rather less than six-sevenths, of their weight, of "dry substance." Common turnips generally contain about one-twelfth; swedes about one-ninth; mangolds about one-eighth, and potatoes about one-fourth, of their weight "of dry substance."]

3. With as much as 5 or 6 parts of total non-nitrogenous to 1 of nitrogenous compounds, in the dry substance of the fattening food of oxen, sheep, and pigs, the increase will probably be very fat. In the earlier stages of growth and feeding, a lower proportion of total non-nitrogenous to nitrogenous compounds is desirable.

4. Taking into consideration the *cost* of the foods, and the higher value of the *manure* from those which are rich in nitrogen, it is frequently the most profitable for the farmer to employ —even up to the end of the feeding process—a higher proportion of nitrogenous constituents in his stock-foods, than is necessary to yield the maximum proportion of increase in live-weight for a given amount of dry substance of food.

II.—Proportion of Parts.

1. *In proportion to their weight*—oxen contain considerably more of stomachs and contents than sheep, and sheep considerably more than pigs; pigs considerably more of intestines and contents than sheep, and sheep more than oxen. Oxen, sheep, and pigs, have nearly equal proportions of the other internal organs: namely, heart and aorta, lungs and windpipe, liver, gall-bladder and contents, pancreas, and milt or spleen, taken together. They have also nearly equal proportions of blood; but the pig rather the least.

2. *In proportion to their weight*—sheep yield rather more internal loose fat than oxen, and pigs very much less than either.

3. As oxen, sheep, and pigs mature and fatten, the internal organs increase in *actual weight;* but they diminish *in proportion to the weight of the animal.*

4. Of the internal offal parts, the loose fat alone increases both in actual weight and in proportion to the weight of the body, as the animals mature and fatten.

5. As oxen, sheep, and pigs mature and fatten, the total "offal" increases in actual weight, but diminishes in porportion to the weight of the body; the "carcasses" increase both in actual weight, and in proportion to the weight of the body.

6. Well bred, and moderately fattened oxen, should yield 58 to 60 per cent. carcass in fasted live-weight; excessively fat oxen may yield from 65 to 70 per cent. Moderately fattened sheep (shorn) should yield about 58 per cent. carcass in fasted live-

weight; excessively fat sheep may yield 64 per cent., or more. Moderately fat pigs, killed for fresh pork, should yield (including head and feet) about 80 to 82 per cent. carcass in fasted live-weight; large, well-fattened pigs, fed for curing, will yield a considerably higher proportion. In each of the three descriptions of animal, the proportion will, however, vary much according to breed, age, and condition.

7. Of the *increase* over the final 6 months of liberal feeding, of moderately fat ($1\frac{1}{4}$ to $1\frac{1}{2}$ year old) sheep, 65 to 70 per cent. may be reckoned as saleable carcass. Of the *increase* over the final 6 months of liberal feeding, of very fat ($1\frac{3}{4}$ to 2 years old) sheep, 75 to 80 per cent. may be reckoned as saleable carcass. Of the *increase* over the final 2 or 3 months of liberal feeding of moderately fat pigs, about 90 per cent. (including head and feet) may be reckoned as saleable carcass.

8. When the fattening food of oxen, sheep, and pigs, contains less than about 5 parts of non-nitrogenous to 1 of nitrogenous compounds, the proportion of gross increase for a given amount of dry substance of the food, will not increase with the increased proportion of nitrogenous compounds; the proportion of carcass to the live-weight will probably be somewhat less; and the carcasses themselves will be somewhat more bony and fleshy, and less fat.

III.—Chemical Composition of the Animals.

1. Of *total dry substance* (excluding contents of stomachs and intestines), the entire body of a fat calf contained about 34; of a fat ox $48\frac{1}{2}$; of a fat lamb nearly 44; of a fat sheep about 50; of a very fat sheep nearly 60; and of a moderately fat pig about 55, per cent. Of leaner animals, the body of a half-fat ox contained $40\frac{1}{4}$, of a store sheep $36\frac{3}{4}$, and of a store pig $39\frac{3}{4}$, per cent., of total dry substance.

2. Of *dry nitrogenous compounds*, the entire body (including therefore, besides flesh, the pelt, hair or wool, bones, and internal organs), of a fat calf contained about $15\frac{1}{2}$; of a fat ox $14\frac{1}{2}$; of a fat lamb $12\frac{1}{2}$; of a fat sheep $12\frac{1}{2}$; of a very fat sheep 11; and of a moderately fat pig 11, per cent. The store animals contained from 2 to 3 per cent. more nitrogenous compounds than the corresponding fat ones.

3. Of *dry fat*, the entire body of a fat calf contained about $14\frac{1}{2}$; of a fat ox 30; of a fat lamb $28\frac{1}{2}$; of a fat sheep $35\frac{1}{2}$; of a very fat sheep $45\frac{1}{2}$; and of a moderately fat pig 42, per cent.

4. In the *store* condition, the entire bodies of calves will probably contain from $3\frac{1}{2}$ to 4 per cent.; of oxen from $4\frac{1}{2}$ to 5

per cent.; of sheep from 3 to 3½ per cent.; and of pigs from 2½ to 3 per cent., of *mineral matter.*

5. In the *fattened* condition, the entire bodies of calves and oxen will probably contain from 3½ to 4 per cent.; those of lambs and sheep from 2½ to 2¾ per cent.; and those of pigs from 1¼ to 1¾ per cent., of *mineral matter.*

6. The mineral matter of the entire bodies of the animals may be reckoned to contain, on the average, nearly 40 per cent. of phosphoric acid, and about 6 per cent. of potash.

7. The mean composition of 6 animals analysed in a condition fit for the butcher, shows about 3 per cent. mineral matter, 13 per cent. nitrogenous compounds, and 33 per cent. fat; in all, about 49 per cent. total dry substance, and 51 per cent. water, and contents of stomachs and intestines.

8. Even in a reputed store or lean condition, the entire bodies of oxen, sheep, and pigs, may contain more dry fat than dry nitrogenous compounds.

9. The entire body of a moderately fat ox contained more than twice as much; that of a fat lamb more than twice as much; that of a fat sheep nearly three times as much; that of a very fat sheep four times as much; and that of a moderately fat pig nearly four times as much, dry fat as dry nitrogenous compounds.

10. The proportion of *mineral matter* in the bodies of oxen, sheep, and pigs, rises and falls with that of the nitrogenous compounds.

11. The *carcasses* of moderately fat beef will probably contain from 50 to 55 per cent.; of moderately fat mutton from 55 to 60 per cent.; of very fat mutton 65 per cent. or more; of moderately fat pigs 60 to 65 per cent.; and of very fat pigs more still, of *total dry substance.* The carcasses of fat lamb about 50 per cent.; and veal carcasses only from 35 to 40 per cent., of total dry substance.

12. The *carcasses* of moderately fat beef will probably contain from 2 to 2½ times; of moderately fat mutton from 3 to 4 times; of very fat mutton from 5 to 6 times; of pigs killed for fresh pork about 4 times, and of pigs fed for curing, a considerably larger proportion, of fat to 1 of nitrogenous compounds.

IV.—Composition of Increase.

1. The *increase* of liberally fed *oxen*, over 6 months or more of the final fattening period, will probably consist of 70 to 75 per cent. total dry substance; of which, 60 to 65 parts will be fat, 7 to 8 parts nitrogenous compounds, and about 1½ part mineral matter.

2. The *increase* of liberally fed *sheep*, over 5 or 6 months of the final fattening period, will probably consist of 75 per cent. or more, of total dry substance; of which, 65 to 70 parts will be fat, 7 to 8 parts nitrogenous compounds, and about $1\frac{3}{4}$ part mineral matter.

3. The *increase* of *pigs* fed for fresh pork, over the 2 or 3 final months on fattening food, will probably consist of $67\frac{1}{2}$ to $72\frac{1}{2}$ per cent. total dry substance; 60 to 65 per cent. fat, $6\frac{1}{2}$ to 8 per cent. nitrogenous substance, and considerably less than 1 per cent. mineral matter. The increase over the last few months of high feeding, of pigs fed for curing, will contain considerably higher percentages of fat and total dry substance, and lower ones of both nitrogenous compounds and mineral matter, than that of more moderately fattened animals.

V.—Relation of Constituents in Increase to Constituents consumed.

1. Sheep, fattening for the butcher on a good mixed diet, will seldom carry off more than 3 per cent. of the consumed mineral matter. The exact proportion will depend very much on the proportion of the mineral matter to the digestible organic constituents of the food. They will probably carry off less than 5 per cent. of the consumed nitrogen, if the food be comparatively rich, and more than 5 per cent. if it be comparatively poor, in nitrogen. They should store up about 10 parts of fat for every 100 parts of non-nitrogenous substance consumed.

2. Pigs, liberally fed on fattening food, will probably carry off from 6 to 10 per cent. of the consumed nitrogen. The proportion will be the less the richer the food, and the greater the poorer the food in nitrogen. They should store up about 20 parts, or more, of fat, for every 100 parts of non-nitrogenous substance consumed.

3. Sheep, fattening for the butcher on a good mixed diet, should give about 9 parts dry increase—consisting of about 8 parts fat, 0·8 to 0·9 part nitrogenous substance, and about 0·2 part mineral matter—for 100 parts total dry substance consumed. More than 90 parts of the consumed dry substance are, therefore, expired, perspired, or voided.

4. Pigs, liberally fed on fattening food, should give 15 to 18 parts of dry increase—consisting of 13 to 16 parts fat, $1\frac{1}{2}$ to 2 parts nitrogenous substance, and less than 0·2 part mineral matter—for 100 parts total dry substance consumed. There will, therefore, be 82 to 85 parts of the consumed dry substance, expired, perspired, or voided.

5. Pigs were found to store up 4 to 5 times as much fat as was supplied ready formed in their food. If the produced fat were formed from starch, about $2\frac{1}{2}$ parts would be required for the formation of 1 part of fat. If the fat were so formed, about one-third of the total dry substance of the fattening food would contribute in a pretty direct manner to the formation of about half that amount of dry increase. In the sense here supposed, only about two-thirds (instead of 82 to 85 per cent.), of the dry substance of the food, would be expired, perspired, or voided, without directly contributing to increase.

The comparative values of our current fattening food-stuffs, *as a source of saleable animal increase*, depend more on their amount of digestible and assimilable *non*-nitrogenous, than on that of the nitrogenous constituents. But, *as a source of manure*, their value will be the greater, the higher their proportion of nitrogenous compounds.

XXIV.—*Report on the Exhibition and Trials of Implements at the Canterbury Meeting.* By H. B. Caldwell, Acting Senior Steward.

It seems to me that when the Royal Agricultural Society has been in existence upwards of twenty years, the Senior Steward ought to be able to write a lengthened account of its progress and success—nor would this be a difficult task; but on taking into consideration that all my information must be derived from the Reports contained in former numbers of the Journal, to which every member of the Society has equal access with myself, I purpose to confine my remarks to the Canterbury Meeting. I much regret that this Report must necessarily be defective, in consequence of my being compelled by illness to leave Canterbury before the trials of Implements were completed. Under these circumstances I find it impossible fully to detail the various incidents of the Meeting, but I shall make some remark on those points which seem to me to call for special notice.

I ought first to mention the beautiful situation of the show-yard, its convenient distance from the town, as well as its proximity to the trial fields, which themselves lay well together.

These advantages were duly appreciated by judges and officials, who, like myself, have at many previous Meetings been walked off their legs in passing from field to field. Moreover the land itself was well selected for the purpose of testing steam-cultivation, comprising various descriptions of ground, rough and smooth, flat and hilly, as is well described by the

judges in their Report. The situation of the trial-fields is, in my humble opinion, one of the most important objects to be kept in view, especially for the sake of exhibitors who have been often taken so far from the implement-yard that, day after day, they were seldom to be found in it. During my short stay at Canterbury I heard no complaints on this account.

A great deal has been said on the subject of points for the judges' decisions; it may, however, be observed, that in addition to the tests supplied by the record of work done, power employed, &c. &c., there have always been points of investigation suggesting themselves spontaneously to the judge's own mind as the results of his experience and knowledge, without which he would not be fit to undertake the various responsibilities of his office; and these considerations, while they hardly admit of being stated in numerical tables, are yet indispensable for arriving at a right decision between the competing implements.

I recommend Local Agricultural Committees to watch the repairs, and ascertain the well or ill-working of the various machines that come out in their neighbourhood: this may be easily done by each man speaking to his neighbour and others at market.

If, moreover, the Royal Society would extend its sphere of action in this direction, great good would be effected.

The Reports of the Judges are generally satisfactory, especially those on the Steam-cultivators and Threshing-machines, both of which will be read with interest. I am sorry that the judges of the steam-cultivators do not include the charge of a second engine, which ought always to be ready, in case of accidents, especially on large farms, or those chiefly consisting of clay land, on which the great object is to prepare the land for root-crops, and to plough leys for wheat immediately after harvest; under such circumstances any risk of interruption in the work becomes important.

I may here remark that steam-cultivation, which is now deservedly in such great vogue, has no exclusive claim to the merit of augmenting our growth of corn. Those who have speculated on its powers, and judiciously applied them, more especially in breaking up stubbles for the next year's root-crops, immediately after harvest, have, without doubt, improved these latter, and also (if the land be properly cleaned by careful and repeated hoeings, &c.) all the crops which follow in succession. But, be it observed, this forward system has for many years been also carried out by horse-power, and has made prosperous farmers in many counties in England.

With regard to the Local Prizes and the Award of the Judges at the adjourned Trial of the Reapers, I shall say but little; but

they appear to me to have taken great pains to arrive at a right decision.

Speaking however from my own experience, both as a Judge at the Royal Agricultural Society's Meetings, and as a farmer, both in Norfolk and in Wiltshire, I must say that I can see little use in a reaper which has not a side delivery. This remark applies especially to the long and bulky straw-crops of Wiltshire. Those who have had experience of the labour of raking off a good crop of corn, will, I am confident, bear witness to the severity of the work. It ried in Wiltshire a machine which drew the corn on to the platform, so that the man had only to rake it off, and yet the work was too severe for a strong man to keep up for any length of time.

In the Kentish trial, the crops are described by the Judges as "average." I am told that the longest wheat was only 3 to 4 feet high, and the barley about 1 foot.

The Judges were, no doubt, influenced in their decision by the cheapness and portability of the Prize Implement, as well as by the crops on which it was tried; and if these latter fairly represent the produce of the district, for such a district that implement may be the best.

It must not be overlooked, however, that the prize was a local prize, awarded by Local Judges; and if, on the one hand, they might fairly select for the prize the reaper best suited to their own neighbourhood,—with them, on the other hand (and not with the Royal Agricultural Society), must rest the chief responsibility of the decision. In this last fact may perhaps be found a reason for the objection made by some implement makers to Local Prizes.

To return, however, to the Prize-reaper, the dynamometer made it take two-thirds of the power of the machine which had the side delivery, and which, by the Judges' Report, was cutting more, by three acres per day. It may therefore be doubted whether even for the generality of wheat-crops the prize implement will be found preferable; but if we take the case of a good barley-crop, with a strong clover ley, which must be laid and left in a swathe until it is properly weathered for the stack, I think the importance of securing a side delivery will appear a still graver matter of consideration. In support of this view let me refer to a passage in a speech of Sir James Graham, delivered in Carlisle in, I think, 1851:—"Before these machines will be of much use to the farmers of England, they must be made self-acting, and deliver the corn without the aid of the man who now works so hard." I believe these words to be perfectly true.

In the preceding remarks I have strongly advocated a side delivery, because after having long felt an interest, and paid

attention to the subject, I have been led by my experience to see its importance to those who wish to get well through their harvest; and I consider that any man acting as a Steward of the Royal Agricultural Society, if he has formed a deliberate opinion on a matter within his department, should not shrink from stating it.

I am decidedly of opinion that too much time and attention are devoted to the Miscellaneous Department, and that the Report of the numerous articles it contains occupies too much space in the Journal. I also hope that the Council will decide what articles are, for the future, to be included in the Miscellaneous Department.

I beg leave to express my best thanks to all the officials for their repeated acts of kindness, and for the readiness with which, throughout my term of office, they have tendered their assistance and support. On this head my own personal acknowledgments are especially due.

I will now conclude this Report (a duty which has devolved upon me one year before the proper time) by again saying how sorry I am that I was unable to be at my post during all the trials of the Implements, and that my account of the Meeting is so poor and incomplete.

Lackham House, Chippenham.

Report of the Judges for Steam Ploughs.

There were five competitors entered for the prize offered "for the class of applications of steam-power to the cultivation of the soil," who describe their entries in the following terms.

No. 1. Coleman and Sons, Chelmsford, Essex.—Patent double 5-prong cul-
and manufactured by exhibitors. Constructed on the principle of the exhi-
tivator for steam-power; invented by R. Coleman, of Chelmsford; improved
bitors' original cultivator, but, by a novel and simple movement, is made to pass sideways into new work when the implement arrives at the land's end, so as to render turning unnecessary. Price 42*l*.

No. 2. Robey and Co., of Lincoln.—Complete set of patent steam-ploughing tackle; invented and improved by Chandler and Oliver, of Bow; and manufactured by the exhibitors. Consists of 10-horse-power portable double-cylinder engine, with the exhibitors' patent steel fire-box. The cylinders are placed on top of boiler. It has Chandler and Oliver's patent drum-ploughing windlass, which revolves on engine's hind travelling-axle, and driven by gearing from fly-wheel shaft; is fitted with governors, link-motion, reversing-gear, and is self-propelling, with one horse steering in front. Water-tank is fixed underneath the boiler to carry a supply of water while travelling by steam; tender to carry engine-driver and fuel, stoking-tools, spanners, &c.; waterproof cover, strong wood travelling-wheels, snatch-blocks, anchors, rope-porters, and 1200 yards of steel-wire rope. Price, inclusive of ploughs, 545*l*., subject to 2½ per cent. discount for cash.

Patent 3-furrow balance-plough and cultivator combined; invented and im-

proved by Chandler and Oliver, of Bow, and manufactured by J. and F. Howard, of Bedford. Price 61*l*., subject to $2\frac{1}{2}$ per cent. discount for cash.

No. 3. Thomas Beards, of Stowe, Bucks.—Eight-horse-power portable double cylinder steam-engine; invented and manufactured by Thomas Ricketts, of Buckingham. Price 250*l*.

(New Implement.) Apparatus for steam-cultivating land; invented by the exhibitor, and manufactured by the Buckingham Castle Iron-Works Company of Buckingham. One set of steam-ploughing apparatus, consisting of pair of drums, with fixings for attaching to portable steam-engine, with set of pulleys and blocks, anchors, rollers, &c., with 900 yards of steel-wire rope. Price 100*l*.

Iron double-furrow plough, invented and manufactured by Howards, of Bedford. Price 6*l*. 6*s*.

No. 4. Alfred Eddington, of Chelmsford, Essex (New Implement).—Windlass for ploughing or cultivating; invented by the exhibitor, and manufactured by A. and W. Eddington, of Chelmsford. Driven by a portable steam-engine, complete with Fowler's anchor for drawing ploughs or any other implement by itself; or it may be worked in combination with the following, no anchor being required. It is self-shifting without any horses, both on the headland and from field to field. Price 200*l*.

Steam-engine; manufactured by Clayton, Shuttleworth, and Co., of Lincoln. Double cylinder, made extra strong, to work at 80 lbs. pressure per square inch, with reversing-gear, and fitted with extra safety-valve, pressure-gauge, and whistle.* Price 315*l*.

Steam-engine; manufactured by Clayton and Shuttleworth; same as preceding. Price 315*l*.

Four-furrow plough; invented by John Fowler, Junr., and manufactured by Ransome, Sims, and Co., of Ipswich. Fowler's ordinary plough with steel breasts. Price 84*l*.

And lastly—

No. 5. John Fowler, Jun., 28, Cornhill, London.—A 12-horse set of steam-cultivating apparatus; invented and improved by the exhibitor, and manufactured by Kitson and Hewitson, of Leeds. 12-horse engine (double cylinder), with self-moving and reversing-gear, windlass and tender, anchor, 800 yards of steel rope, headland rope, 20 rope-porters, 2 snatch-blocks, and field-tools complete. Price 699*l*.

Balance 4-furrow surface-plough; invented and improved by exhibitor, and manufactured by Ransome and Sims of Ipswich. Fitted also with scarifier-hearts, adapted to be worked by the same traction-tackle. The furrows capable of being set to plough a furrow of $9\frac{1}{2}$ to $12\frac{1}{2}$ inches wide. Price 81*l*.

The trials were commenced on Wednesday, July 4th, on Folly Farm, the field selected presenting great capabilities for testing the working powers of the implements to be tried. The soil was a moderately strong loam on an indurated gravelly subsoil, and in some portions of the field was strongly held together by the growth of indigenous herbage. About two-thirds of the lengths ploughed were level, with a considerable inclination at the end; the level portion was in old clover-ley; the other had been in peas sown on the ridge, and in old grass of the most worthless character. An old farm-road crossed a portion of the upper part of the field, which presented a considerable obstacle to the working of the implement (Fowler's) in whose allotment it was.

Steam-plough trials have become so familiar to the agricultural public that

* Neither the horse-power of the engines, nor the description and length of rope supplied, are specified.

a very brief description of the different apparatus entered for competition is all that is here necessary.

Coleman's cultivator is fully described by his entry. This may be used as an auxiliary implement by any possessor of power and of traction tackle.

Robey and Co. have adopted Smith's system * of traction, with the improvement of a triangular instead of a rectangular arrangement of the rope. A double set of ploughs are carried on an iron frame ; the ploughs being shifted in and out of the ground at the end of the "bouts" by means of a strong lever, worked by the man in charge.

The engine had two cylinders, 7¼ inches in diameter, with a 12-inch stroke, and was driven at the rate of 160 revolutions per minute, at a pressure of 50 lbs. on the square inch. This, allowing 3-10ths for friction, would give a mean working-power equal to 28 horses.

Beard's apparatus was upon the same principle also, differing only in its working arrangements. The winding-drums were firmly fixed by screw-bolts to the hind part of the engine, and were worked by a pitch-chain, driven direct from the main shaft. A very simple and ingenious movement distributed the rope in winding equally over the surface of the drum, preventing the overlapping so injurious to the rope and to the regular working of the apparatus generally. The plough used was a double one, made of iron in the ordinary manner; and the tackle was arranged so as to work merely up and down ; the anchor-blocks requiring to be shifted frequently as the work proceeded. The engine had two cylinders of 5½ inches diameter, with a 10½ inch stroke, and was driven at the rate of 160 revolutions per minute, with a pressure of 50 lbs. on the square inch, which would give a working-power equal to 14·109 horses.

Eddington employed a double set of apparatus to do the work. An engine, mounted on a travelling-frame carrying the winding-drums, was placed at each end of the space to be ploughed. The ploughs (Fowler's patent), of which two sets were required, worked up to the centre of the ground and then returned to their respective starting-places. The engines being placed directly over the winding-drums, communicated motion to them very readily and also to the driving-wheels of the carriages, which were self-moving as the work advanced : while the great resistance its own weight offered to the lateral strain of the traction-rope rendered any system of anchorage quite unnecessary. The engines used had single cylinders 9 inches in diameter, with a 12-inch stroke, and were driven at the rate of 130 revolutions per minute, with a pressure of 55 lbs. per square inch : thus giving a working-power equal to 19¼ horses.

The general arrangement of Fowler's apparatus is too well known to be again described. From year to year improvements have been introduced into the working details, while the strength and finish of the engine exhibited, and, indeed, of all parts of the apparatus, were worthy of every commendation.

Fowler's engine had two cylinders 7½ inches in diameter, with a 12-inch stroke. It was driven at the rate of 140 revolutions per minute, with a pressure of 68 lbs. on the square inch, equivalent to a working-power of 35·68 horses.

The trials were continued during the 4th and two following days on the land already described ; when, after testing their respective powers in various ways, the following results were obtained :—

* Smith's and Fowler's apparatus and working arrangements are described and illustrated, vol. xix., p. 326.

Names.	Area Ploughed.			Time.		Coals Consumed.
	A.	R.	P.	hrs.	min.	lbs.
Robey and Co. ..	1	1	8	2	16	224
Beards	0	1	38	1	28	91
Eddington	1	0	26	1	8	201
Fowler*	0	2	38	0	40	137

Taking these results as representing their full working capacities respectively, we find that the quantity of land ploughed per day of 10 hours, and the quantity of coals consumed per acre, would stand thus:—

Names.	Area Ploughed per day of 10 hrs.			Coals Consumed per Acre.	Coals Consumed per Day.
	A.	R.	P.	lbs.	cwts.
Robey and Co. ..	5	2	37	172·3	8
Beards	3	1	12	186·6	5½
Eddington	10	1	1	172·9	16
Fowler	11	0	10	185·76	18½

The cost per acre we estimate as follows; the details of working expenses are given below:†—

Names.	Cost Price.		Working Cost per Day.			Work done per Day.			Cost per Acre.	
	£.	*s.*	£.	*s.*	*d.*	A.	R.	R.	*s.*	*d.*
Robey and Co. ..	606	0	1	19	1½	5	2	37	6	8
Beards	356	6	1	15	1½	3	1	12	10	2
Eddington	1198	0	3	7	6	10	1	1	6	8
Fowler	780	0	2	10	1	11	0	1	4	6

* An apparent error in noting the quantity of coals consumed by Fowler rendered a second trial necessary. This, however, confirmed the results obtained in the first, and was therefore not continued longer than the time reported.

† Estimated working expenses per day, assuming 200 as the number of days they would be at work in the year:—

Robey and Co.'s.	£.	*s.*	*d.*
Four men 11*s.*, two boys 3*s.*	0	14	0
Water-carting	0	4	0
Coals, 8 cwt.	0	8	0
Oil, &c.	0	1	0
Interest at 5 per cent., and wear and tear at 15 per cent., on cost price, 606*l.*	0	12	1½
	1	19	1½

Beards'.	£.	*s.*	*d.*
Five men	0	13	6
Water-carting	0	4	0
Coals, 5½ cwt.	0	5	6
Oil, &c.	0	1	0
Removal	0	4	0
Interest at 5 per cent., and wear and tear at 15 per cent., on cost price, 356*l.* 6*s.*	0	7	1½
	1	15	1½

Eddington's.	£.	*s.*	*d.*
Six men 16*s.*, three boys 4*s.* 6*d.*	1	0	6
Water-carting	0	5	0
Coals, 16 cwt.	0	16	0
Oil, &c.	0	2	0
Interest at 5 per cent., and wear and tear at 15 per cent., on cost price, 1198*l.*	1	4	0
	3	7	6

Fowler's.	£.	*s.*	*d.*
Two men 6*s.*, two boys 4*s.*	0	10	0
Water-carting	0	5	0
Coals, 18½ cwt.	0	18	6
Oil, &c.	0	1	0
Interest at 5 per cent., and wear and tear at 15 per cent., on cost price, 780*l.*	0	15	7
	2	10	1

Having thus obtained the cost of ploughing per acre by the different apparatus tested, we were desirous of comparing it with the cost of ploughing by the ordinary horse-labour of the farm ; and here we were enabled, by means of the very ingenious dynamometer of Mr. Amos and the valuable tabulated calculations of Mr. Morton,* to deal with more reliable data than mere opinions or estimates. To test the actual resistance of the soil, an ordinary iron plough (Busby's) was used, to which the dynamometer was attached, the traction force being supplied by the nearest engine. Six furrows were drawn in different parts of the field of the same depth and width as those turned by the steam-ploughs, the dynamometer giving the following results :—Average distance travelled, 192 yards ; power consumed, 52 ; revolutions of counter, 21 ; time consumed, 3·75 min. ; and showing that the force required to overcome the resistance of the soil was 692·32 lbs., or rather more than the traction-power of 4 horses, moving at the rate of $2\frac{1}{2}$ miles per hour.†

According to Mr. Morton, the average cost of horse-power on a farm may be taken at 6*d.* per cwt., drawn $2\frac{1}{2}$ miles. In ploughing an acre of land, with a 10-inch furrow, the plough would have to be drawn about 10 miles : consequently, the draught, say 6 cwt. × by the distance 4, × by the cost per cwt., 6*d.*, would give 12*s.* per acre as the *minimum* cost of ploughing an acre of the land in question by horse-labour, which, indeed, was the estimate given by practical farmers on the ground during the trials.

The comparison, then, between steam and horse ploughing is largely in favour of the former on ground offering such resistance. The least efficient of the competing machines (Beards') showed a saving of 1*s.* 10*d.* per acre, = 15 per cent. Robey and Co.'s and Eddington's showed a saving of 5*s.* 4*d.* per acre, or = 45 per cent. ; while Fowler's work was done at a saving of no less than 7*s.* 6*d.* per acre, or 68 per cent. less than by horse-labour.

The *second set* of trials took place on the following day (7th), in an adjoining field, where the increased inclination of the surface offered far greater obstacles to tillage cultivation. Indeed, the land had most probably never before been ploughed *up and down*, but always *across* the hill, and then evidently only in a very superficial manner. Directions were given for the several competitors to light up their fires, and to move, as soon as ready, to the stations allotted to them, and then to plough the area assigned to each. The length of the piece to be ploughed was 330 yards, the land having a rise of 1 in 10 throughout the entire length, which, in one place, for a short distance, was increased to 1 in $4\frac{1}{2}$, as is shown at A and B in the accompanying section. Fowler's engine-fire was lighted at 9·12, and steam sufficient to move it to the new station was generated at 10·13, when the necessary preparations for ploughing were made, and work commenced at 11 A.M.

Robey and Co. lighted up their fire at about the same time, and reached their station at 10·20. The necessary preparations were completed at 11·25, when they commenced work.

The other two competitors, Beards and Eddington, withdrew from the trial after having commenced operations. Beards' apparatus, though quite suitable

* "On the Cost of Horse-power," by J. C. Morton, R. A. S. Journal, vol. xix., p. 437.

† Formula for reducing the results of plough dynamometer (Amos):—

2546 = constant number.

$$\frac{2546 \times N}{L} = S.$$

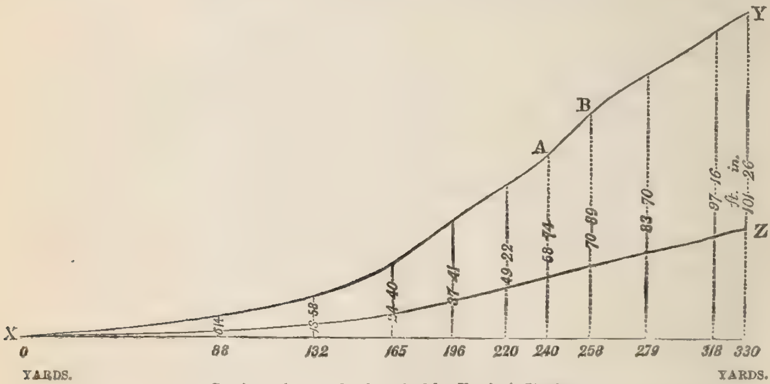
$$\frac{2546 \times N}{T \times 11{,}000} = HP.$$

$$11{,}000 = \frac{33{,}000}{3 \text{ ft.} = 1 \text{ yard}}$$

N = No. of revolutions of counter.
T = time in minutes.
L = distance in yards.
S = strain in lbs. on ropes.
H P = horse-power.

to the ordinary conditions of tillage, was not equal to this very severe test, and, after two or three turns, during which the ploughs were with great difficulty held in the soil, the work was discontinued. Eddington's system of ploughing requires an engine and winding-tackle at each end of the field; this arrangement possesses the great advantage that no anchors or snatch-blocks are required, and that, when once on the ground, the work may be commenced forthwith. In this case, however, the extreme gradient of the field presented such difficulties that the engine could not be got to its station at the upper end of the land until the trials were too far advanced to render it desirable to proceed, and it was accordingly withdrawn from competition.

SECTION of ARABLE FIELD, adjoining FOLLY FARM, as worked by the Steam Ploughs, July 7, 1860.



Section taken on land worked by Fowler's Engine.

(XY. Profile as shown according to the practice of engineers, the horizontal scale being in yards, the vertical in feet.

XZ. Outline as it would appear to the eye when a scale of yards is taken in each direction.—P. H. F.)

The area assigned to each was exactly 1½ acre. The portion allotted to Fowler was completed at 1 h. 34 m. The work was done in an admirable manner by the same plough-frame as had been used in the first trials. In this, however, 3 furrows only were taken up the ascent, and 4 when returning down. Robey and Co. completed their portion at 4 P.M.; but, owing to the extreme tenacity and indurated condition of the subsoil, combined with the great inclination of the surface, the power of the apparatus appeared to be overtaxed, and the work done was not equal to that performed by the same ploughs in the former trials.

The results of the day's work may be thus given:—

Names.	Lighted up.	Took up Station.	Commenced Ploughing.	Finished Ploughing.	Area Ploughed.
Fowler	9·12	10·13	11·	1·34	1½
Robey and Co.	9·10	10·20	11·25	4·	1½

The actual resistance of the soil was tested by the dynamometer attached to an iron plough (Busby's) and drawn by Fowler's engine. This showed an average draught of 1375·39 lbs. *up*, and 1220·8 lbs. *down*, the hill; or a mean of 1298·09 lbs., equivalent to the traction-force of 7¾ horses. According to the calculations already referred to (Morton's), this would cost 23*s.* per acre; indeed, the estimates for the work done, given by practical farmers on the

field, were from 30*s.* to 36*s.* per acre, though it was evidently impossible for horse-labour to have turned the same furrow at all.

Comparing these estimates with the data already given of the rate and cost of work done by the steam-ploughs, we find that Fowler ploughed 1½ acres in 2 h. 34 m.; or, in round numbers, 6 acres per day of 10 hours, at a cost of 50*s.* 1*d.* per day, or 8*s.* 4*d.* per acre; and that Robey and Co. ploughed the same area in 4 h. 35 m.; or, in round numbers, 3⅓ acres per day, at a cost of 39*s.* 1½*d.*, or 11*s.* 8*d.* per acre. The saving effected by the steam-plough in the one instance (Fowler's) being equal to 60 per cent., and in the other (Robey and Co.'s) equal to nearly 50 per cent., as compared with horse-labour.

Throughout the whole of the trials the quality of the work done was very satisfactory. This point, however, we look upon as secondary to the more important question "of the *application of steam-power* to the cultivation of the soil;" as when we are in possession of a well-arranged system of steam-power, we can make use of any form of implement we please to act upon the soil. In the trials on the level land, the quality of the work done by Robey and Co. was fully equal to that by Fowler. On the hilly ground, however, the superior power and arrangement of Fowler's machine enabled it to maintain its former excellence, while the work done by Robey and Co.'s was not equal to its previous performance.

In the exercise of the functions committed to us, we therefore decide that a prize of 90*l.* be given to Mr. John Fowler, junr., for his 12-horse set of steam-cultivating apparatus, invented and improved by himself, and manufactured by Kitson and Hewitson of Leeds; and that a prize of 10*l.* be given to Robey and Co. of Lincoln, for their complete set of patent steam-ploughing tackle, invented and improved by Chandler and Oliver of Bow, and manufactured by exhibitors. We also award a commendation to Thomas Beards, of Stowe, near Buckingham, for his 8 horse-power portable 2-cylinder steam-engine, invented and manufactured by Thomas Richetts, of Buckingham, and for his apparatus for steam-cultivating land, invented by the exhibitor and manufactured by the Castle Iron-Works Company, Buckingham.

Wm. Owen, Rotherham.
Owen Wallis, Overstone Grange.
Canterbury, July 9th, 1860. John Wilson, Edinburgh.

Supplementary Report.

The annual trials of Steam-Ploughs, of which details have been given in the present and in previous reports, have made known the different principles of their construction and of their working arrangements, and the results of the trials have borne testimony to the quality of their performance in the field.

These trials, however, have always been carefully prepared for, and carried on under exceptional conditions, while, at the same time, their duration has been too short to give them that practical value which alone can satisfy the public as to the advantages Steam-Ploughs actually possess.

It appears to us that the time has now arrived for testing, by a prolonged trial on the farm, their capability of sustaining the character they have acquired in the trial-field for economy and excellence of work. We beg, therefore, to suggest to the Council of the Royal Agricultural Society of England the desirability of a prolonged trial—say for six consecutive days—under such conditions as to soils and season as the Council may consider most suitable for practically testing their powers.

William Owen, Rotheram.
Owen Wallis, Overstone Grange.
John Wilson, Edinburgh.

Report of Judges of Thrashing Machines.

HORSE-POWER THRASHING-MACHINES.

The entry for trial of horse-power thrashing-machines were unusually small, being only three in number. The introduction of steam-power for thrashing has so limited the demand for these machines that little attention seems to be paid to their manufacture. The trials were conducted without the dynamometer, and in awarding the prize we were mainly influenced by the quality of the work. The competitors were :—

Name.	Stand.	Article.	Price of Machine.	Horse-power.
			£. s. d.	
Wallis and Haslam	123	2325	54 12 6	4
Tasker and Sons	95	1853	55 0 0	4
Hensman and Son	148	2665	73 0 0	5

The prize of 20*l.* was awarded to Messrs. Wallis and Haslam.

STEAM-POWER THRASHING-MACHINES.

Owing to the non-attendance of several of the leading manufacturers, there were fewer machines entered for trial than on previous occasions: this is to be regretted, as we think it of some importance to the public to know whether the machines which had prizes awarded them at the Chester meeting still maintain their position. In offering the prize in Class III. the Society definitely stated that no machine could compete which could not be driven by 8-horse power. To ascertain correctly the power taken by each machine we had the assistance of Messrs. Appold and Amos, jun., who worked the dynamometer throughout the trials, thereby relieving us of great responsibility. The number of machines entered for trial was 19, of which 4 broke down, 9 exceeded the prescribed power, and 6 only could compete for the prize. In the first trial we determined to decide the merits of each by a system of points, and annexed is a tabular statement of the results.

Of the 6 machines eligible to compete for the prize we selected 4 for a second trial. In order to arrive at a just conclusion, and ascertain correctly their good or bad points, we decided that each machine should be subjected to a trial of 30 minutes, and the power required to drive it should be recorded by the dynamometer. We allowed each exhibitor to be sole manager of his machine, with the view to make its performance as effective as possible. The quantity of corn sacked was then weighed, and from the chaff, calder, and other refuse, was taken by one of Messrs. Hornsby's dressing machines all the corn which otherwise would have been thrown away; this also was weighed and noted down against each machine. It was extremely gratifying to hear each exhibitor express his approval of this test, and from the accompanying Table, coupled with the workmanship, price, and general performance of each machine, we awarded the prizes as follows, viz. :—

Prizes.	Name.	Stand.	Article.
1st Prize 30*l.*	Gibbons and Co. ..	123	283
2nd ditto 20*l.*	Humphries	26	475
3rd ditto 10*l.*	Savory	39	713
A Silver Medal ..	Turner	65	1143

Class III.—First Trial.

Name.	Time.	Total Horse-power for One Minute.	Average Horse-power.	No. of Sheaves Thrashed.	Clean Thrashed.	Clean Shaken.	Cavings free from Corn.	Chaff free from Corn.	Chaff free from Cavings.	Corn uninjured.	Straw unbroken.	Chaff free from Seeds.	Total of Points.	Price.	Stand.	Article.
No. of Points indicating Perfection					100	70	70	50	20	50	20	20				
	Minutes.													£.		
Gibbons (Wheat) ..	11·66	91·55	7·85	100	100	70	70	50	20	50	20	15	790	105	18	283
Ditto (Barley) ..	8·58	57·9	6·6	50	100	70	70	50	20	50	20	15				
Humphries (Wheat)	17·25	131·8	7·55	100	100	70	70	40	20	50	20	15	775	85	26	454
Ditto (Barley)	7·02	46·5	6·4	50	100	70	60	50	20	50	20	20				
Savory (Wheat) ..	25·83	145·58	5·6	100	100	70	30	20	10	50	20	15	630	95	39	713
Ditto (Barley) ..	8·133	49·4	6·	50	100	70	30	20	10	50	20	15				
Forster (Wheat) ..	18·33	166·25	8·96	100	50	60	60	..	5	50	15	5	555	100	51	854
Ditto (Barley) ..	10·75	60·86	5·66	50	75	60	60	40	5	50	15	5				
Gilbert (Wheat) ..	18·56	132·7	7·	100	50	35	25	20	20	50	20	10	480	95	66	1167
Ditto (Barley) ..	9·65	55·8	5·7	50	75	35	25	25	20	40	20	10				
Turner (Wheat) ..	30·6	136·7	4·46	100	75	60	70	50	20	50	15	..	675	65	65	1143
Ditto (Barley) ..	7·8	32·19	4·1	50	75	50	70	50	20	50	20	..				

Class III.—Second Trial.

Name.	Time.	Total Horse-power for 1 Minute.	Average Horse-power.	Weight of Corn Thrashed.		Weight of Corn taken from Chaff, Calder, and Refuse.	Prizes.
	Min.			Stones.	lbs.	lbs.	
Gibbons	30	219·9	7·3	95	..	4	1st Prize 30*l.*
Humphries ..	30	204·	6·8	89	3	5	2nd ditto 20*l.*
Savory	30	199·7	6·65	82	..	2	3rd ditto 10*l.*
Turner	30	144·77	4·82	42	3	5	Silver Medal.

Joseph Druce.
John Brasnett.

Report of Messrs. F. King *and* Edward Whittle *on the Implements tried by them at Canterbury.*

The implements tried by us were chaff-cutters, grinding-mills with stone and steel grinders, linseed and corn-crushers, oil-cake breakers, turnip-cutters, and root-pulpers, all worked by power.

Quality of work was our first consideration, and all the machines were tested by the dynamometer. The able assistance of Mr. Easton, jun., made our task much easier. The machines were generally well constructed, and made good work.

Class IV.—Chaff-cutters.

Time of working, 3 minutes. Barley-straw used; length tested $\frac{3}{8}$-inch.

Name of Exhibitor.	Stand.	Article.	Price.	Power required.	Chaff cut.	Award.	Remarks.
			£. s.		lbs.	£.	
H. Carson, Warminster.	49	820		20,830	63½	10	Three knives, reverse gear, an improved front feed-plate.
E. Bentall, Maldon.	101	1931	13 13	..	..	..	The quality of the chaff cut, and whole arrangement of this machine, were very good.
Richmond and Chandler, Manchester.	41	758	16 0	..	..	..	A good machine, reverse gear. Quality of chaff good.

Class VI.—Grinding Mills with Stone Grinders, for Grinding Agricultural Produce into Meal by Steam or Horse Power.

Time of working each machine, 10 minutes. Barley used.

Name of Exhibitor.	Stand.	Article.	Price.	Power required.	Meal produced.	Award.	Remarks.
			£.		lbs.	£.	
Ashby and Co., Stamford.	68	1226	35	25,000	50½	5	
John Tye, Lincoln.	121	2286	42*	23,852	64	5	*Portable ditto 55*l.* 10*s.*

The machines in this Class were very much improved.

Class VII.—Grinding Mills with Steel Grinders, for Grinding Agricultural Produce by Steam or Horse Power.

Time of working, 2 minutes. Barley used.

Name of Exhibitor.	Stand.	Article.	Price.	Power required.	Meal produced.	Award.	Remarks.
			£. s.		lbs.	£.	
Hunt and Pickering, Leicester.	73	1276	6 10	4774	36½	8	
Howard, Riches, and Co., Norwich.	194	3795	31 10	..	..	Highly commended.	This machine we highly recommend, either for grinding beans or barley into fine meal, or splitting corn; and we think it is almost equal to the grinding mills with stone grinders.

Class X.—Linseed and Corn-Crushers by Steam or Horse Power. Time of working, 2 minutes. Oats and Linseed used.

Name of Exhibitor.	Stand.	Article.	Price.	Power required.	Weight crushed.	Award.	Remarks.
			£. s.	Oats.	Oats.	£.	
Turner, Ipswich	65	1148	12 12	35,000 Linseed. 38,000	27 lbs. Linseed. 20 lbs.	5	This machine worked with much less power than any tried in this Class.
Wood and Son, Stowmarket.	128	2414	11 11	..	..	..	Both good machines.
E. Bentall, Maldon.	101	1941	10 10	..	..		

Class XII.—Oilcake Breakers for Large and Small Cake, by Steam or Horse Power.

Time of working, 2 minutes.

Name of Exhibitor.	Stand.	Article.	Price.	Power required.	Cake broken.	Award.
			£. s.		lbs.	£.
E. Bentall, Maldon.	101	1945	7 7	35,100	134	7
Dray and Co., London.	165	3028	11 0	35,200	149½	3

Class XVI.—Turnip and Root Cutters.

Name of Exhibitor.	Stand.	Article.	Price.	Award.	Remarks.
			£. s.	£.	
Picksley & Co., Manchester.	77	1357	5 10	10	This is the only Root-cutter we tried, which did a large quantity of work in a little time. It is a very cheap machine.

Class XVII.—Root Pulpers.

200 lbs. Mangold used.

Name of Exhibitor.	Stand.	Article.	Price.	Power required.	Time.	Award.	Remarks.
			£. s.		m. sec.	£.	
E. Bentall, Maldon.	101	1955	8 18	32,508	1 26	4	A very good pulper; teeth easily repaired.
Barnard & Co., Norwich.	35	619	7 0	33,264	1 1	2	

F. King.
Edward Whittle.

Oilcake-breakers, Root-pulpers, Turnip and Root Cutters and Slicers, Chaff-cutters, Grinding-mills with Steel Grinders, Grinding-mills with Stone or Steel Grinders, Linseed and Corn Crushers, Bone and Bone-dust Mills, &c.

The implements and machines allotted to us for trial belonged to that section of the Prize Sheet which has reference to the preparation of food for stock, comprising linseed-cake breakers, root-pulpers, root cutters and slicers, chaff-machines, grinding-mills, linseed and corn crushers *for hand-power*, and bone and bone-dust mills for steam, water, or horse power. These were nearly all tested by the dynamometer in the shed arranged for the purpose, so that the actual power required to work them was accurately ascertained. We shall, as we proceed, describe in detail the way in which the trials were conducted for each class of machines. We may observe, however, that in all cases "quality of work" was our chief consideration; without that the other elements of excellence, such as principle of construction, time and power required, &c., were not admitted as real claims for the prizes, &c.

Oilcake-breakers.

The amount of money offered for prizes (viz. 5*l.*) in this class was divided and awarded according to the merits of the implements. Each machine was worked five minutes, and the weight of cake passed through each, the quality of work done, and the power consumed, were duly registered, with the following results:—

Name of Maker.	Lbs. weight of Cake broken in 5 Minutes.	Units of Power required to Break 1 lb. of Cake.	Quantity of Cake that can be Broken per Hour.	Price.		
			lbs.	£.	*s.*	*d.*
Nicholson	39	71·02	468	3	13	6
E. R. and F. Turner	48	121·5	576	3	10	0
Picksley, Sims, and Co. ..	25	603·2	300	3	10	0
T. W. Ashby and Co.	43	81·4	516	3	10	0
Hunt and Pickering	36	55·6	432	3	7	6
Bentall	27	37·	324	3	13	6
Smith Brothers	71	133·8	852	3	15	0
Johnson and Whitaker ..	32	31·3	384	5	10	0

The 1st Prize of 3*l.* was awarded to .. Bentall.
The 2nd Prize of 2*l.* was awarded to .. Hunt and Pickering.
Highly commended .. .. T. W. Ashby and Co.

The machines, of which a considerable number were exhibited, were generally well constructed, with the exception of one, which employed twelve times the amount of power to do less work than the best machine tried, though both were made exactly on the same principle. The defect arose from the bad way in which the machine was fitted or put together.

Root-pulpers.

Of this class of machines for preparing food for cattle, only seven were tried, as the application of hand-power to this purpose is very limited, steam or horse power being found more suitable and economical, particularly as the work is generally done at the homestead. In testing these machines we had 108 lbs. of roots (mangold) weighed and given to each, recorded the time and power employed, and then decided accordingly.

Name of Maker.	Time.		Units of Power expended in executing the Work.	Quantity Pulped per Hour.	Price.		
	min.	sec.		lbs.	£.	*s.*	*d.*
Barnard, Bishop, and Barnards	4	0	27,480	1620	4	10	0
Picksley, Sims, and Co. ..	10	30	31,820	617	4	4	0
Hunt and Pickering	4	38	21,920	1440	5	0	0
Bentall	5	20	34,820	1215	6	6	0
Woods and Son	6	2	23,000	1023	4	15	0
James Mellard	Withdrawn.			..	6	10	0
Johnson and Whitaker ..	9	48	29,930	621	3	15	0

The Prize of 2*l.* 10*s.* was awarded to .. Mr. Bentall.
The Prize of 1*l.* 10*s.* was awarded to .. Hunt and Pickering.
Commended .. .. Barnard and Bishop.

The work done by most of the machines was good, but the difference between them was considerable. The first prize machine reduced the roots to pulp as evenly as possible, and it was the only one that did so. Some of the others cut the roots into shreds. The one that was withdrawn was fed on the inside of the cylinder; the knives were fixed so ill that they choked up in a very short time.

Root Cutters and Slicers.

The machines exhibited in this class were numerous and generally well constructed; in some of them valuable improvements had been made since they were last tried, particularly in one of Gardner's, made by Mr. Bentall, which had a double action and an apparatus separating the dirt and small pieces from the roots during the process of cutting. We adopted the same principle in testing these machines as in the case of pulpers, viz., we had 108 lbs. of roots weighed and given to each machine, and registered the time, power, &c.

Name of Maker.	Time.		Units of Power expended in executing the Work.	Quantity Sliced per Hour.	Price.		
	min.	sec.		lbs.	£.	s.	d.
Barnard, Bishop, and Barnards	2	20	11,120	2777	4	10	0
Carson	1	50	9,500	3534	4	10	0
Bentall	2	13	5,970	2923	4	10	0
Bentall	2	55	7,630	2221	5	10	0
Picksley, Sims, and Co. ..	1	55	6,500	3381	4	15	0
Mellard	3	30	17,600	1851	5	10	0
Johnson and Whitaker ..	3	43	10,100	1743	5	10	0
Johnson and Whitaker ..	2	48	6,020	2314	5	10	0
Trustees of W. Crosskill ..	..		26,230	948	8	10	0

A Prize of 4*l.* was awarded to .. .. .. Mr. Bentall.
A Prize of 2*l.* was awarded to .. .. .. Mr. Carson.
And commended (as a slicer also) .. .. Mr. Bentall.

The exhibition of chaff-cutters for hand-power was very good, the machines being generally well constructed. We tried them all with very short barley-straw, as it came from the threshing-machine; each machine worked five minutes, mechanical time, by the dynamometer. The chaff cut was weighed, and the quality of the work, &c., duly recorded.

Name of Maker.	Weight.	Units of Power required to Cut 1 lb. of Chaff.	Quantity of Chaff cut per Hour.	Price.		
	lbs.			£.	s.	d.
Page and Co.	14½	1675·8	174	7	0	0
Gardner	Choked during the trial			7	16	0
Gardner	Not prepared for trial.					
Jas. Cornes	16	1228·1	192	4	15	0
Hill and Smith	No pulley to go to trial			6	10	0
Allcock	12	1727·5	144	7	10	0
Johnson and Whitaker ..	10	1844·	120	4	10	0
Richmond and Chandler ..	13½	1683·8	162	5	10	0
Carson	14	1798·	168	5	10	0
Picksley and Sims	15½	1470·9	186	6	0	0
Bentall	15½	1590·3	186	6	16	6
Ashby and Co.	10½	1430·4	126	6	0	0
Snowden	8½	2889·4	102	8	18	6
Cornes and Son	11½	993·	138	3	10	0

The 1st Prize of 5*l.* was awarded to .. Mr. Cornes.
The 2nd Prize of 3*l.* was awarded to .. Mr. Bentall.
The 3rd Prize of 2*l.* was awarded to .. Richmond and Chandler.
And Page and Co. received a high commendation.

But very few mills were exhibited in Classes 8 and 9. We selected several for trial, but two only were tried. One of these when fed with barley did its work well, both in producing fine meal and a coarser sort for feeding purposes; but the operation was so exceedingly slow, and the power required so excessive, that we felt bound to withhold the prizes altogether.

Linseed and Corn Crushers adapted to Hand-power.

In this class also there were but few exhibitors, it being found very much more economical to apply steam or horse power to this work. We tried, however, three machines; both in crushing linseed and oats the work was exceedingly good, especially if we take into account the power used. There was nothing particularly new in either of them to call for special comment; we worked them all five minutes, mechanical time, weighed the produce of both linseed and oats, and recorded the power required by each mill for each kind.

Name of Maker.	Kind.	Quantity in lbs. Crushed in 5 Minutes.	Units of Power required to Crush 1 lb. of each.	Quantity of Seed Crushed per Hour.	Price.
		lbs.		lbs.	
Messrs. Tasker ..	Withdrawn.				
Woods and Son ..	Linseed	$12\frac{1}{4}$	3173·8	147	5 10 0
Woods and Son ..	Oats ..	$10\frac{1}{4}$	4353·1	123	
Bentall	Linseed	$16\frac{1}{2}$	3115·1	198	6 6 0
Bentall	Oats ..	$10\frac{3}{4}$	3282·7	124	
E. R. and F. Turner	Linseed	13	2515·3	156	8 0 0
E. R. and F. Turner	Oats ..	$13\frac{3}{4}$	3674·1	160	

The 1st Prize was awarded to .. .. Mr. Bentall.
The 2nd Prize was awarded to .. .. Messrs. Turner.

Bone and Bone-dust Mills.

In this class we had five bone and two bone-dust mills for trial. We tried each mill five minutes, and observed the quality and quantity of the work done, and decided as follows:*—

For Bone Mills.

The Prize of 5*l.* was awarded to The Trustees of W. Crosskill.
The Prize of 5*l.* was awarded to The Trustees of W. Crosskill.
Highly commended .. .. .. Picksley and Sims.
Commended .. .. Oldham and Booth.

Bone-dust Mills.

The Prize of 10*l.* was awarded to The Trustees of W. Crosskill.
And commended .. .. .. Oldham and Booth.

* The dynamometer could not be applied to these trials in consequence of the great amount of power required by some of the mills at a low rate of speed.

Pickslcy and Sims exhibited a small but useful mill for a farmer, as it would grind about 2 tons per day in a very efficient manner, requiring only 2-horse power to work it. That exhibited by Messrs. Rankin made very inferior work as compared with the others; it ground the bones indifferently, and the screen to separate the ground bones worked so badly that it made scarcely any separation, and was completely choked up before the time for working had expired.

In concluding our Report we may be perhaps allowed to add, that the absence of two very efficient Stewards, Messrs. Caldwell and Pope, caused much regret. The former was taken ill when on his way to Canterbury; the latter, from an unforeseen cause, was compelled to return home; so that the whole superintendence of the trials devolved upon Lord Leigh the remaining Steward.

We can speak with satisfaction of the manner in which the Foremen and Yardmen generally performed their duties, and of the ready assistance which they afforded us whenever we required it.

John Hicken, Bourton-on-Dunsmore, near Rugby.
George Matthias Hipwell, Cheam, Surrey.

Report of the Judges of the Miscellaneous Department.

The Judges of the miscellaneous implements have great pleasure in presenting their Report on the implements and machinery which it fell to their lot to inspect at the Canterbury Meeting.

A cursory view of the show of implements at once made us sensible of a falling off in the exhibition as compared with the Warwick, Chester, and other previous meetings. This was owing to the absence of the well-known stands of many of our leading implement-makers, which we could not do otherwise than deplore. The laudable exertions of other exhibitors, great as they were, failed to supply the deficiency.

The Warwick Catalogue contained 412 pages, descriptive of 245 stands; the Canterbury Catalogue contains but 296 pages, descriptive of 212 stands—thus showing a great reduction of the number of exhibitors, but a still greater reduction in the number of articles shown.

The Miscellaneous Judges have constantly to reply as they best can to remarks and objections made, and also to entertain suggestions offered by exhibitors in passing round upon their duties. One complains that no prize is ever offered for articles of his class of manufacture; another, exhibiting the most general collection, asserts they are all of agricultural character; another asserts that his fire-engine is an agricultural pump; another argues that his range-grate must pass on account of the steam-apparatus attached; another, that his blasting-apparatus is certainly entitled to pass as an agricultural appliance; another that his school-desks must pass—"they are for parochial schools." Then we have the whole class of washing-machines, besides many articles and machinery exhibited under the following heads, *i.e.*—filters, flower-stands, garden-archways, garden-seats, and implements; pedestals, vases, syringes, &c., for garden uses, and alarum-bells for tenders of corn, seeds, &c.; then cucumber-slices, barometers, bedsteads, carpet-sweepers, office-mills, chairs and tables, copying-machines, cork-drawers, counting-machines, dish-covers, door-frames, door-mats, fire-bars, fishing-rods, fountain-designs, fruit-plates, gas-apparatus, grafting-tools, butchers' knives, lanterns, lightning-conductors, meat-covers, microscopes, photographs, quoits, road-scrapers, roasting-machines, sausage-machines, sewing-machines, sign-paintings, tents, union-jack flags, urns, varnish, &c., &c., &c., in great abundance and variety. We name these to show that Judges in this class

must have perplexing doubts as to the category under which articles like these should be included, useful as most of them are, but not decidedly agricultural. We would suggest most respectfully that a committee or commission should be appointed by the Society to settle these questions.

We desire to say that, in pursuing our duties throughout the late exhibition, we scrupulously avoided noticing any implements or machines or class of machines likely to come into competitive trial in due course in the quadrennial cycle. We had great difficulty in withholding the Society's honours in this respect, as our attention was repeatedly called to what were termed new implements, or new machines, or improvements thereon. We, however, took the responsibility of referring the various exhibitors to the time when they would, according to the standing rules of the Society, be brought into full competition. Hence, it will be seen that our awards were much restricted, particularly as we had no power of marking our approval of whole stands, however much we admired them; but the honours were to be confined to meritorious implements or machines, "agricultural articles, or essential improvements." We may, however, in this Report express our high approval of very many stands which would add great interest to any showyard. We beg to name the following as eminently worthy of commendation:—Messsrs. John Warner and Son's stand of pumps and hydraulic machines; the Trustees of Mr. Crosskill's stand of carts, waggons, mills, wheels, axles, portable railways, troughs, pumps, &c., &c.; Richard Reid's stand of probangs, watering-machines, pumps, &c.; Ebenezer Thornton's stand of washing and mangling machines—the latter exceedingly good; James Coultar's stand of drills, &c. (we noticed his improvement in the box to the wheels). Ransome's mouse-traps elicited our approval. We selected Bradford's washing-machine for a short trial, and, with a very dirty assortment of clothing, it washed them thoroughly and wrung them nearly dry in six minutes; we gave it a commendation. Richmond, Chandler, and Norton's was an excellent stand. Henry Hayes showed a capital stand of carts and waggons, beautifully got up. Isaac James showed a superior washing-machine. Hugh Carson kept up in full efficiency his highly-useful stand of implements. John Reynolds exhibited some very pretty rosaries, archways, stands, baskets, and other ornamental garden requisites, in wire, &c., &c. The Agricultural Engineers' Company exhibited a very extensive and excellent collection of most useful implements, machinery, and other articles in great variety and suited to every agricultural purpose: it was so extensive as to represent nearly every firm in the kingdom. Bonds and Robinson are new exhibitors: their horse-rake and horse-hoe are two very useful implements. E. T. Quinton's bread-making or kneading-machine met our approval. Messrs. E. R. and F. Turner had, as usual, a good stand of their superior crushers, bruising and grinding mills, &c., &c. T. W. Ashby and Co. had an excellent stand of haymaking-machines, chaff-cutters, horse-rakes, cake-mills, circular revolving harrows, &c., &c. Thomas Aveling's stand of steam-engines, thrashing-machines, elevators, horse-gearing, and other machinery, met our very high approval: his universal safety-joint to his driving-shafts is worthy of extensive patronage. John Baker's dressing-machine is a good and cheap one. Hunt and Pickering had a good stand of crushers, breakers, pulpers, ploughs, &c.; also garden-seats, &c.: their patent oil-box to plough-wheels is commendable, as are also their cheap twitch-rakes. The straw thatch-making machines of Maggs and Hindley are effective, and bid fair to obtain more extended patronage. Thomas Nalder's new corn separator and blower, fitted with metallic brushes to clean the rotating screen, deserves our especial notice. Dicksley and Sons exhibited a good and extensive variety of chaff-cutters, mills, pulpers, slicers, pig-troughs, also washing-machines, garden-chairs, and other useful articles, &c. William Sawney's admirable corn-

dressing machines and screens obtained our best attention; the vibrating motion given to the screens secures perfect separation. Edward Page and Co. show a capital stand of ploughs, harrows, chaff-cutters, horse-hoes, horse-rakes, &c., &c.; also their small but very effective brick and tile machines. The St. Pancras Company exhibited a splendid stand: we commended their stable-fittings, and, had our rules permitted us, we should have highly commended the whole stand. At Brown and May's stand we found Romaine's admirable models of his rotating cultivator and endless railway—the latter a great improvement upon the Boydel's shoes. Holmes and Sons had a good stand: their new machine for cleaning chaff from dust, seeds, straw, &c., we thought worthy of special remark. W. Weeks had a good stand of implements and apparatus, chiefly connected with the cultivation and subsequent management of hops: we had the pleasure of awarding him a silver medal for his apparatus for drying hops, invented by P. S. Punnett, Esq. Hill and Smith's stand comprised an excellent and very extensive assortment of goods in their especial department, harrows, rollers, iron gates, rick-stands, wire-fencing, tree-guards, ornamental entrances, &c., &c.: we awarded them a high commendation for their iron vermin-proof rick-stand. Amies and Barford had a good stand: their mode of fixing Lyne's stile in strained wire fencing is good. George Foord had an excellent stand of first-class implements; many of Howard's implements were on it: we awarded him a high commendation for his very compact and cheap parish school-desk. E. H. Bentall had one of the best and most extensive stands in the yard: we would gladly have marked our high approval of it. Brown and Co. had a very attractive stand, consisting of lawn-mowers, iron hurdles, gates, vases, garden-seats, flower-stands, netting, &c., &c., in great variety. Greening and Co. exhibited their superior collection of iron gates, wire fencing, hurdles, rabbit-fences, tree-guards, continuous wrought-iron bar-fences—all very desirable and worthy of commendation. Mapplebeck and Lowe show, as usual, an admirable stand of miscellaneous articles, implements, hand-tools, weighing-machines, garden-seats, ornamental chairs, vases, &c., &c. Thomas Kennan and Son exhibit their usual assortment of useful tools, &c.: we awarded them a commendation for their cheap and effective wire strainer. R. H. Crisp showed some excellent strapping of different sorts: we awarded him a commendation for his specimens of gutta-percha and india-rubber strapping. Wallis and Harlam showed an excellent stand of cultivating implements. Woods and Son deserve honourable mention for their excellent stand of miscellaneous articles and machines. Peyton and Clerk show admirable specimens of axes, adzes, mattocks, and other farm-tools in great and good variety. William Ball exhibits his excellent ploughs, waggons, carts, scarifiers, &c. William Gerrans brought out a self-acting horse-rake, taking 11 feet when in work, with a joint to raise one part to facilitate travelling; the workman rides upon it, and, by pressing a pedal, causes the rake to deposit its load as it passes on; it has also a lever left behind for the same purpose: of course we left it to its quadrennial year's trial. James Mellard showed some good and attractive implements. Thomas Milford and Sons exhibit their excellent waggons and carts. Messrs. Mitton and Co. show their pretty flower-stands, baskets, seats, netting, meat-safes, &c. Samuel Rowsell shows his light and handy gate and American horse-rake. Thomas Perry and Sons had a very good and extensive stand of miscellaneous articles of their usual manufacture. Dray, Taylor, and Co. show a considerable variety of superior articles, implements, and machines. H. A. Thompson had his usual good stand of implements, *i.e.*—haymaking-machines, rakes, pumps, &c. Robert Tinkler shows a capital stand of barrel-churns, with their india-rubber bungs. Cottam and Co. show a great number of excellent articles, besides their superb stable-fittings, for which we awarded a commendation, in which we desired to include the whole stand. William

Dray and Co. show many good articles: their forge for farm-service is a good one, and their field-gate has the novelty of its bars being sawn and the ends reversed, which is said to give it additional strength. Isaac Speight's horse-hoe attracted our best attention; but, as it is not the year for the trial of horse-hoes, we declined to notice it as a new implement. John and George Drury and William Henry Biggleston, Canterbury, exhibit a stand very numerously supplied with superior implements, machinery, and miscellaneous articles, in very great and good variety: we should have been much pleased to have awarded a high commendation to this excellent stand had our rules permitted. J. and F. Hancock's butter-making machines we also declined to notice, this not being the year for the churning and butter-making trials. Plenty and Pain exhibited a singular but very useful shepherd's house for bleak situations. F. Morton had a capital stand of iron gates, wire fencing, straining-pillars, &c., all strong and good. Ward and Burman's brick-making machine we also declined to remark upon for reasons before stated. Mr. B. Gibbs's superb collection of grain, grasses, seeds, roots, &c., &c., was as attractive as ever, and adds much to the interest and information of the visitors. Messrs. Lawson and Son add to a similar collection a pleasing variety of ornamental trees, shrubs, &c. H. Bridge's stand of pretty butter-prints, &c., always pleases us. George Spill's stand of rick-covers and other articles highly deserves our notice. Thus, having taken a very brief notice of most of those implements and machines which fell more immediately within our department in the yard, we will now say a word or two upon those implements and machines we put under a short trial. And first of F. Reimann's sowing plough or drill, invented by Mr. Pruneau. The chief characteristic is an ingenious contrivance to regulate the deposit of seed by clockwork machinery and graduated slides; this it would undoubtedly effect, supposing the horse to move also by clockwork at an even and self-regulated pace: we thought it very ingenious but not very practical. We also put under our inspection in work Ward and Burman's brick-making machine or clot-former named above. Its chief novelty and value appeared to consist in its adaptation to form clay into clots of proper size for the moulding-machine; this is done by putting the clay into the hopper, when, by the machine being set in motion, the die advances to become filled with the clay, and, as it recedes, by other appliances the clay is forced out and taken by the attendant—as one die advances the other recedes, and so is continuously filling and forcing out: we could pass no opinion upon its merits for the reason above stated. We also carefully examined a novel and Utopian invention of D. L. Banks. It is no less than a suspension railway, supported upon wheels, to traverse headlands, while the rail is suspended from either headland upon these wheels, on which are also fixed at either end an engine-house, with engines and all requisites complete. Thus these rails are to support two engine-houses, two engines, the suspension-rails, with all the machinery required for draft in ploughing or cultivation; the forced extension of the rails is by a balance-power also at either end: we think it unnecessary to express an opinion as to the merits of this apparatus. Ericsson's caloric engine was under trial for several hours. It has a cylinder at one end and a furnace at the other; cold air is admitted through a valve into the piston, and, when expanded by the heat, it forces the piston forward. This outward stroke furnishes the available power, which, by acting through the balance-wheel, forces the piston to its original place, expelling the expanded air, and introducing a fresh supply of cold air for the succeeding stroke. It was said to be about two horse-power; but, upon a careful trial, it was proved not to exceed the third of one horse-power: we regretted this much, as hoping it would prove another available power of a cheap and safe character for farm-service. Another still more impracticable machine was exhibited by the inventor, J. Evans, called a weed-exterminator. It was

designed to collect weeds, convert them immediately into manure, and spread them on the land. It consists of a kind of scarifier-frame, with wheels and shafts; the row of scarifier-tines collects the weeds; between these tines revolving teeth carry up the weeds on to an endless web; this web further carries them up and throws them into a lighted furnace in a barrel or drum the width of the machine, from which they are thrown or scattered through gratings on to the soil as the machine passes along: we had it tried more as a matter of curiosity than to prove its efficiency, feeling assured that it must be useless, and so it proved. We also, for an instant, saw the gorse-machine of Messrs. Picksley and Sims in work: it unquestionably fulfilled its promise of reducing gorse effectually, and rendering it fit food for cattle.

The only money prizes coming directly under our adjudication were the prize for field-gates and the prize for hand-tools suited for hop-grounds. For the latter there was very little real competition, and we were enabled, with the sanction of the Local Judges for hop-cultivators, to award the prize of 5*l.* to Spear and Jackson of Sheffield.

For field-gates there was an extensive and good competition; many, however, were excluded by the condition that the price was not to exceed 1*l.* 5*s.* After a prolonged and careful inspection of all the gates in the yard (and certainly they were distributed, to our inconvenience, all over it), we had the gratification of awarding the prize of 5*l.* to Lord Leigh, of Stoneleigh Abbey, Kenilworth, for a very strong and highly useful gate. Upon this point we desire to remark that nearly all the gates we saw were very unscientific in their construction, the chief suspension-bar being invariably attached or fixed from the head instead of the back or hanging style of the gate.

JOHN CLARKE.
W. TINDALL.

Report of the Judges of Implements entered for the Local Prizes, at the Meeting of the Royal Agricultural Society, held at Canterbury, 1860.

There were seven mowing machines selected for trial, which were set to work on a piece of level meadow-land, near the Show-yard, in an average crop of grass, in fit order for mowing.

After having given to the exhibitors full opportunity to develop the peculiar merits which their respective implements were stated to possess, the Judges selected four machines for competitive trial, both in the grass and in a piece of standing clover.

Ultimately the machine, No. 77, "Wood's Improved," exhibited by W. M. Cranston, and the machine, No. 82, invented by J. A. Allen, and exhibited by Messrs. Burgess and Key, were closely tested against each other.

Both machines cut the crops remarkably well; ant-hills, stones, inequalities of the ground, and a crop laid in different directions, appeared to be no hindrance to their *effective* progress, and the draught of the two implements differed but little. The Judges considered that, in overcoming the above difficulties and in cutting the clover-crop, the machine, No. 82, had slightly the advantage; that it was more substantial in its construction, especially in the cast-iron gear work, and better adapted to withstand the rough usage to which farm implements are liable, and they therefore awarded the prize of 10*l.* to Messrs. Burgess and Key.

Eight reaping machines were ordered out for trial on a light piece of unripe rye, growing on the slope of a hill, and subsequently four were selected for competition on the side of a steep bank, in another part of the same field. The crop was laid by a heavy roller in various directions, the surface of the ground was very uneven, stony, and full of weeds, and offered a good opportunity for testing the mechanical capabilities of the several machines for encountering difficulties of the above character.

In this trial the only machines which appeared capable of getting through the work without stoppages or derangement of their parts, were article No. 81, exhibited by Messrs. Burgess and Key; article No. 794, exhibited by Robert Cuthbert and Co.; and article No. 3299, exhibited by W. Dray and Co. The Judges were unanimously of opinion that the trial was unsatisfactory and insufficient, and deferred their award until they should have had an opportunity of giving the three last-mentioned machines a further trial, as they consider that the merits of a reaping-machine can only be satisfactorily tested in harvest time, and on ripe crops of different kinds of corn.

The implements exhibited for the cultivation of hop lands proved to be in no respect superior to those in ordinary use in the county, and the Judges therefore withheld the prize.

Mr. William Weeks, of Maidstone, exhibited a simple, effective, and much improved machine for pressing hops, article No. 1651, for which the Judges awarded him the prize of 10*l*. There was only one design exhibited for the most economical building adapted for drying hops, and as it differed in few respects from the oast-houses now usually erected in the county, the Judges did not feel justified in awarding the prize.

The prize for the apparatus best adapted for drying hops was not awarded, there being no opportunity to test practically the merits of the respective articles exhibited.

There were 24 entries for the prizes offered "for the plough on the turn-wrest principle, or otherwise best adapted to turn the furrow-slice according to the Kentish system of ploughing."

There were other ploughs in the Show-yard, the exhibitors of which were very desirous of having them tried in competition, but as these ploughs were not adapted to lay the furrows all in one direction, the Judges did not consider themselves justified in ordering them out for trial.

The ploughs were set to work on an old pasture, on a stony clay soil, very ill adapted for the purposes of a trial ground, and it soon became evident that it was utterly impracticable for any plough to fulfil the conditions attached to the premium, the Judges therefore requested that another piece of land should be selected. The ploughs were then sent to a trifolium ley, near the Show-yard, where the soil was of medium quality; the ploughs then did some very good work, turning over a furrow-slice 10 inches wide and 8 inches deep, laying the furrows all in one direction, turning them completely over, leaving a good crease for the reception of seed, and the surface of the soil in a good state for the action of the harrows.

The draught of the three ploughs to which the prizes were awarded varied to some extent, but the old-fashioned Kent plough, which appeared to be the heaviest and most clumsy in its construction, proved to be the lightest in draught, and made excellent work, with an average draught of 803 lbs.

The prizes were awarded as follows:—

The first prize, 30*l*., to Mr. F. B. Elvy, Bow-hill, Maidstone.
The second prize, 20*l*., to Mr. J. Wildash, Davington, Faversham.
The third prize, 10*l*., to Mr. Joseph Simmons, Rainham, Sittingbourne.

P. S. Punnett.
Thos. Rammell.
Fredk. Murton.
H. G. Austin.
Thomas Abbott.

Report on the Postponed Trial of Reaping Machines, exhibited at the Show of the Royal Agricultural Society, held at Canterbury in July, 1860.

The deferred trial of reapers took place at Barton's-Court Farm, near Canterbury, on Tuesday, September the 4th; the competition was confined to the

machines exhibited by Messrs Burgess and Key, No. 81 in the catalogue; by Robert Cuthbert and Co., No. 792; and by W. Dray and Co., No. 3299; those having been the only machines selected in July last for future trial by the Judges.

The implements were set to work in a piece of wheat—an average crop for the season—which was laid at places in two or three directions by a roller, and they were afterwards taken to a light piece of barley in which there was a strong plant of clover.

During a short preliminary trial Dray's machine nipped off some of the wheat ears, and left them in small lumps, about two rods apart; this defect was caused by a screen on the platform in front of the man who delivered the cut corn, and as it could not be remedied in the field, the Judges required Mr. Dray to retire from the contest.

The other two reapers cut the wheat remarkably well, except where badly laid; in this respect they were considered to be equal in merit; furrows and bottom rubbish appeared to offer no impediment to the progress of the machines.

The Judges were unanimously of opinion that, in doing a certain quantity of work in a given time, Burgess and Key's machine had the advantage in the proportion of 10 to 7, and that the delivery of the crop, when cut, was better effected by their machine in the proportion of 6 to 4.

That in lightness of draught Cuthbert's machine had the advantage in the proportion of 14 to 9, and that in the cost of cutting and binding up the corn, Cuthbert's machine had the advantage in the proportion of 6 to 4.

That in simplicity of arrangement, in the strength and durability of the working parts of the machines, Cuthbert's appeared to have the advantage in the proportion of 6 to 4.

That in compactness, handiness in transit and management, and in price, Cuthbert's machine had the advantage in the proportion of 4 to 2.

The Judges were placed in some difficulty on account of one of the competing machines being provided with a self-acting side-delivery, by which the crop, when cut, was laid in a continuous swathe; the other machine being adapted for the delivery of the crop by manual labour at the side, at intervals, in a fit state for binding up.

The Judges considered that, in heavy crops of corn, the self-acting delivery would give Messrs. Burgess and Key's machine a considerable advantage over Cuthbert's, and that the excess in draught in Messrs. Burgess and Key's machine may, to some extent, be attributed to the power requisite to keep the self-delivering apparatus in operation, but they have some doubt whether the weight of the larger machine would not be found objectionable on retentive soils in wet seasons.

The Judges were of opinion that, with crops of an average length and bulk of straw, the cut corn could be delivered at the side from Cuthbert's machine in a fit state for binding up, by manual labour, without further exertion than is usual in the extra hard work of harvest operations; and that for light crops, or where the corn is laid or scrawled, Cuthbert's machine is preferable to Burgess and Key's.

The prize of 10*l.* was unanimously awarded to Mr. Cuthbert's machine, No. 792, and Messrs. Burgess and Key's machine was highly commended.

P. S. Punnett.
Thos. Rammell.
H. G. Austin.
Fredk. Murton.
Sept. 21, 1860. Thos. Abbott.

XXV.—*The Canterbury Meeting*. By P. H. Frere.

After the lapse of several months few subjects lose more of their attractiveness, both for the writer and the reader, than that of an Agricultural Show. Graphic accounts of the Canterbury Meeting appeared at the time from the pens of writers whose specialty it is to enlarge on the beauties and merits of high-bred stock. To copy these would be plagiarism; to vary, but to change them for the worse; and yet some notice of the Meeting is called for, that the niche appropriated to 1860 may not be quite vacant in the annals of our Society.

Although the Meeting was not a successful one, especially in a financial point of view, justice has been rendered on all sides to the motives which determined the Society's choice of a locality. The cordiality with which the town and corporation of Canterbury first invited and then received us deserves an acknowledgment, in which great part, if not all, of the county may claim a share.

If agriculturists were not tempted to visit Kent to see improved farming, or were disappointed if they looked for it, there were other lessons which they might read if they thought of the "yeoman of Kent, with his yearly rent," contrasted with the beggarly nobles, squires, &c., of old times, and then caught a glance of a stray modern specimen of this sturdy but slow and tenacious race. Though the men of Kent have little resemblance to the hare, assuredly their course in the race of agriculture has been not unlike that of the hare in the fable,—they had a good lead, and have not kept it. Perhaps the very strength of the soil is against progress: bad managers cannot well exhaust it, and none but very good management can improve it.

The site and arrangement of the show-yards was all that could be desired; if that assigned to implements was not as full as usual, this is hardly the place to canvass the causes which led to a decrease in the number of exhibitors.

The Journal of the Royal Agricultural Society is designed to be an abiding record of purely scientific matters connected with the progress of agriculture; its pages would be very ill-filled by references to misunderstandings which cannot be too soon forgotten. Its editor, moreover, whose duties lead him to seek for information and cordial co-operation from all quarters, is the person whom it would least befit to entangle himself in what may be called the politics of the Society.

In the stock-yard, although some breeds of animals were rather scantily represented (as was to be expected in that south-eastern nook of England), yet some classes (for instance, that of short-horn heifers) were very strong; and in almost all there

were specimens enough to content a virtuoso who would prefer a choice cabinet to a large gallery of pictures.

Among short-horn bulls the portrait of the "Royal Butterfly" has thus been drawn: "With really a line of beauty running along him, a splendid forehand, great girth and size, and true symmetry, he unites in the highest degree the yet more innate (intrinsic?) advantages of quality and pedigree. He has, too, a grand, massive head, kindly expression, but still with all the attributes of the male animal, while his condition was admirable."

It appears that the "Prince of Prussia," his competitor, did not show to quite the best advantage.

Amongst younger bulls, Mr. Majoribanks' "Harkaway" (sire, the "Great Mogul") was one of the most taking, his quarters and touch being remarkably good.

The success of Captain Gunter's twin heifers ("Duchesses") was, of course, a distinguishing feature in the Show. In the 3 year-old heifer class, Mr. Ambler had the honour of beating another "Duchess" with his "Wood Rose." The short-horn judges report, that they were decidedly of opinion that the animals they have highly commended in all the classes would have been entitled to prizes, if those to which prizes have been awarded had not been exhibited.

The Herefords were well, but not fully, represented: other and better opportunities may be found for criticism on the comparative merits of the leading representatives of this breed.

The Devons, though so far from home, formed a nice "cabinet collection." It is to be regretted that the standard of excellence in this breed is to some extent a matter of debate.

Among the sheep, Mr. Jonas Webb and Mr. Sanday maintained their pre-eminence for Southdown and Leicester rams. Mr. Heasman, a new exhibitor, was fortunate enough to beat Lord Walsingham with his shearling ewes. In the Cotswold rams, Mr. J. Walker and Mr. R. Garne took the lead in a department which was generally commended. But attention was especially attracted to the classes in which the Hampshire and Oxford Downs were exhibited, in consequence of the marked advance which these breeds (especially the former) have made of late. Mr. Humphrey, Mr. S. King, and Mr. Channing were among the most successful exhibitors of Hampshire or West Downs; whilst the judges assigned many high commendations to the Oxford Downs as the best solution of their difficult task of comparing things unlike in themselves. The Shropshire sheep had already attained to separate prizes and classes, and were represented in a manner to justify this decision.

The judges in these classes report to me as follows:—

"The breeders of Shropshire sheep have certainly taken pains to show that they deserve to be recognised by the Royal Society. Thirty-seven shearling rams were entered in these classes, among which were many most creditable specimens. No. 594, which obtained the first prize, bred by Mr. Horton, shows great constitution, heavy flesh, and good character; and No. 614, from Messrs. Crane's flock, is still more level, although possessing less substance.

"But it is in the class for All-Aged Rams that the merits of this breed are most conspicuous. No. 644, shown by Mr. Byrd, is a splendid animal, combining size and form with the finest quality; he obtained the first prize, and does great credit to his breeder. No. 635, exhibited by Mr. Horton, has immense substance, with excellent quality. No. 638, Mr. Holland's; No. 639, Mr. Keeling's; and No. 647, Mr. Preece's (the former, especially) are remarkably good; No. 630, Mr. Sheldon's; and No. 636, Mr. Mansell's, also elicited the commendation of the judges. The yearling ewes, too, were very good: two pens from Messrs. Crane's flock (No. 655 and No. 654) obtained the prizes by their size, quality, and character; and No. 652, Mr. Holland's, were so good that the judges expressed their regret that in this class, and also in the class for all-aged rams, there was not a third prize to award. The ewes shown by the Earl of Dartmouth, Mr. Evans, Mr. Mathews, and Mr. Smith, were most creditable to this rising breed of sheep."

The judges expressed a hope that in future the Shropshire sheep would be placed upon an equality, as regards the number of prizes, with the other classes of sheep.

If there was a star amongst agricultural horses, it was decidedly Mr. Barthropp's two-year-old stallion "The Pilgrim." I read again with pleasure "of his fine arm, running into a clean flat leg; his blood-like quarter, finishing off in rare muscular thighs and sound hocks; his good middle, and already well-developed crest;" and if others were as much gratified by seeing him as I, they too may be glad to have his image recalled to their recollection.

The show of pigs was considered good, and Messrs. Crisp, Hewer, Sexton, Harrison and Wainman stood foremost among the successful competitors.*

For the account of the non-agricultural horses I gladly refer to the Report with which Mr. Welby has been so obliging as to furnish me. I beg, in conclusion, again to plead the lapse of time as a reason for not going more into detail as to the merits of the prize animals.

XXVI.—*Report on the Riding Horses and Ponies shown at Canterbury, with Remarks on the present Breed of Riding Horses.* By J. Earle Welby, one of the Judges.

In consequence of its having been suggested to me, at the last Canterbury Royal Agricultural Meeting, that any remarks and

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* A Report was received from the judges of pigs in February, too late for publication.

suggestions on the classes which came under our notice, as Judges of riding-horses, might be acceptable, I have committed to paper a few general remarks on the classes, as also on the subject of our riding-horses at the present time—their failings and deficiencies.

And first, on Class I. — "For thoroughbred Stallions for getting Hunters," &c., for which 25*l.* and 15*l.* have been the rates of remuneration, I would venture to remark, that having watched this class since the establishment of the Royal Agricultural Meetings, I have come to the conclusion that it is one which in all districts is worthy of the patronage of the Society: it gives variety to their Shows, it attracts a number of people who are not much interested in the beasts and sheep, and so adds grist to the mill; and, if only the prizes be liberal, and so worded as to ensure the entry of the most valuable horses, available for general use in the field and on the road, it must command success in almost every district, for all Englishmen love a horse, especially those of the Northern Counties. Yet ever since the Royal Agricultural Society first instituted this prize, the class has been but a small one, owing to the fact that owners of valuable horses are not to be tempted to send to a distance, under a prize of 100*l.* The entries have therefore been generally restricted to those kept within easy distance of the Show. Still I have seen some useful horses gain the prizes: I can mention "Canute," a fine powerful horse (who likewise gained many local prizes); also "Spencer" and "Sir Peter Laurie," when, as at Lincoln, local prizes were given to this class of horses; and, lastly, at Canterbury, "Dagobert" deserved to be successful, as he possessed fine action, and a wiry, hunting-like frame. At Middlesborough the example (which I am happy to see the Royal Agricultural Society intend to follow at the ensuing Leeds Meeting) of giving 100*l.* was a decided success, inasmuch as it brought together a show of fine horses. No doubt it was won by the best, "*Voltigeur*," and *possibly* (but this was a question) the second-best was "The Cure." But since the former of these covers at 50 guineas a mare, the second at 25 guineas; I say that the 100*l.*, *for all practical purposes*, was thrown away, as these first-raters do not want encouragement. The racing world patronises them, and there is no fear of their deteriorating as race-horses—then, why give 100*l.* to an animal who is at the "top of the tree," and of no use to the breeder of hunters or hackneys? It would surely be better to give a prize of 100*l.* for the best horse which is available at a fee not exceeding 5*l.*—a limitation which, in my belief, would not prove injurious to the Show. I could mention many horses equally

valuable for hunter sires with "Voltigeur" or "The Cure," but which may be shut out or frightened from competing with the crack racing-sires of England. At the Show above-mentioned there were several *available* horses whose merits entitled them to a first prize.

The horse that we want to encourage for improving our breed is not necessarily the high-class race-horse, (though no doubt many of them are first-class in every respect—many I say, though by no means all, for even Derby and St. Leger winners are to be found most faulty in shape); but the stout wearing plate-horse—one that combines constitution and stoutness, with good knee action and power. Such animals are rare among the present thoroughbreds, and therefore require encouragement. The chief faults of the common run of race-horses lie before the saddle. How many of these have thin withers and straight shoulders, are pinned in their elbows, and—worst fault perhaps of all—have upright pasterns, to which may be added a great want of power and constitution! They have so long been bred for speed, and taught from yearlings to go on their shoulders, that they have well nigh lost the springy level action which is so essential to form a perfect riding-horse. I would not wish to be understood to advocate the half-bred in preference to the thoroughbred stallion—far from it: if the latter can be found with power and action, it is decidedly to be preferred; but if such cannot be easily met with, then I advocate the use of a good horse with a stain in his pedigree, rather than a bad, weak, though perfectly bred, race-horse. This leads me to suggest that in *Class I.* it should not be deemed absolutely necessary that it should be for "the *best thoroughbred* stallion, but for the "*best stallion*" for getting hunters, &c., "pedigree being especially taken into consideration." I see, however, that the prize at Leeds is published for the "best *thoroughbred* stallion;" and though I doubt not the quality shown will not be found in any way deficient or unworthy of the 100*l.*, yet it is on the cards that a fine specimen of the high-bred hunter might be disqualified from competing by the insertion of the word *thoroughbred.* Of the large class of riding men by far the greater part know little, and care less, about racing and race-horses; they do not want to see the racing cracks, but they do want to see an assemblage of hunting stallions up to 12 or 15 stone, and such may be now shut out, whilst a "Voltigeur" or a "Cure," who confer no benefit on any but the racing public, carry all before them. As "like begets like," is it not reasonable to suppose that a horse that has shown great jumping powers and lasting qualities over the country will hand down those especial qualities

to his offspring, and therefore be a more certain card to rely on than the racing sire who has been educated for several generations to go on his shoulders?

I have seen many of the best hunters and hackneys got by half-bred horses—horses, too, that commanded high prices in the market. I can point to two sons of "Mundig," at this time in Lincolnshire, one called "The Red-Cross Knight," the other "The Grey Prince." Both these are out of quite half-bred mares; but, be it observed, that the cross is not that of soft Cleveland, but of good stout hunting-blood. Their stock possess great power and endurance, and have realised very high prices; as a good specimen I can point to "Saucy Boy," at Willesden paddocks, a winner at several steeple-chaces. Again, there is a still higher class of half-bred horse to be met with, containing most excellent sires—in fact, the real cock-tail racer—such as "Gobbo," "Accident," "Wild Hero," &c.: even these would be debarred from taking the 100*l.*, though essentially race-horses and better than three-fourths of the horses in training. I should like therefore to see the hunter and hackney to a certain degree distinguished from the race-horse; and I think this may be effected by encouraging a *type* as high-bred as possible, not necessarily thoroughbred (for from this source it is almost hopeless to attempt to get power enough for heavy weight), selected with an eye first of all to action and strength, and therefore with special regard to fine shoulders and well-placed forelegs. Among our thoroughbred horses there are decided lines which in a remarkable manner hand down certain perfections or imperfections. At the present time the "Birdcatcher" and "Sir Hercules" line is that best calculated to improve our riding horses. They all possess action, and may be known by the general airiness of their forehands, and the good setting on of their necks, shoulders, and forelegs, with the drawback of a predisposition to curby hocks. Then there is the well-known Touchstone strain; of large size, faulty in their shoulders and ancles, and remarkably powerful in their loins and hind legs—a most valuable line, if judiciously crossed, combining great stoutness and speed.

These are the two great lines of the present day, and which by a careful admixture of blood may be brought nearer to perfection than any. Among others there is the Bay Middleton line, one which has done much to diminish the general utility of horses, being an infirm, leggy, and light-middled sort.

To this I may add the Melbourne and the Venison lines; the former notable for handing down great size and good limbs, the other for possessing wiry but light frames. There are many other lines of descent, but the above are the most in vogue. It

is only by careful and judicious crossing from such lines that we can hope to approximate to the perfect animal; but the ignorance and carelessness which are daily shown in the selection of the parents, is lamentable in the extreme. Hence the many middling animals bred—hence the constant failures. And why? simply because the breeder will not weed out with unsparing hand the indifferent stock which he may rear, but perseveres in the idle hope that some day a trump may turn up.

At the late Canterbury Show, with the exception of "Dagobert," who was a well-turned wiry horse, with good action, not one other horse was exhibited in my department worthy of a prize, or calculated to do any good in the district in which he travelled. It is true, that after some hesitation a prize was awarded to "Comet," by "Planet," a horse (as a writer in the 'Field,' at the time, justly remarked) too light, and scarcely worthy of a prize; but as he possessed soundness and action, it was better to err on the safe side, and encourage the entry of horses that at least are sound.

It is needless now to enter upon a description of the other stallions shown at Canterbury, but they were of a stamp quite unfitted to benefit the breed of any district. Two of them were mongrels, *i.e.* (as dealers say) of no trade whatever; and among horses, as dogs, above all beware of mongrels! And yet how extensively is this class of nags, as he calls them, patronised by the small farmer! The reason is, they only ask a low price and go round to the farmers' homesteads, thus saving risk, trouble, and money at the time, and illustrating in the end the "penny wise and pound foolish" principle: although extraordinary good animals have occasionally resulted from the cross of the thoroughbred stallion and cart mare, these instances are quite exceptional, and such wide crosses are to be deprecated. For hunters, the most injurious cross of all is that with the soft, specious, Cleveland Bay. There is scarcely a district in which one or more specimens of the *Yorkshire Horse*, as it is termed, is not abundantly used. Even Ireland, which was formerly proverbial for blood, and where consequently hunters were eagerly sought for, is now debased and half-ruined by this flat-catching strain. The reason for the general increase of Cleveland blood is, that they are flashy, dealers' horses; they come to early maturity, and have great size and good colour. Not but that for their own particular purpose, of London carriage-work, they are a handsome and valuable breed; but unfortunately, of late years, a demand has sprung up for a quicker and lighter horse, which has led to more blood being wanted for that market. Hence has arisen a cross between the thoroughbred horse and

Cleveland mare, by which cross, as I said above, the hunting blood has been contaminated and half spoilt.

Having so far suggested what I conceive must be an advantage to the Class I.—the opening it to any horse of high class most fitted to get hunters—I would say a few words on the other classes: those for hackneys, ponies, and, though last, not least in importance, brood mares.

If there is one animal more difficult to get than another, it is the old-fashioned hackney, combining blood with power and moderate height. This class at Canterbury was of the worst sort; but at the Yorkshire meetings I saw them come out in great force, though even in the most favoured districts I cannot award to them much praise. The old-fashioned hackney has nearly degenerated into the coarse, vulgar, butcher's horse, with generally coarse head and hairy heels. It is, in fact, a very chance-bred horse; and though one now and then sees a blood-like cob, it is quite a rarity. This class surely should be encouraged at the Royal Agricultural Show, and a 30*l.* prize would not be thrown away upon it. As to the prize for ponies, I recommend that it be withdrawn and the amount added to those assigned to more useful classes. This does not of course apply to meetings held in Welsh or other pony-rearing districts: although at Chester meeting, as I remember, the ponies presented but a sorry show.

Leaving to others the duty of discussing the merits of the agricultural horse, and of calling that attention which the importance of the subject demands, to the fearful amount of unsoundness which existed among the cart stallions exhibited at Canterbury, I come to the class of hunting, hackney, and harness mares: one which, as I hold, requires the patronage of the Society more than any other, except that last alluded to—the Society's natural bantling. Our stallions throughout England are, comparatively speaking, much sought after—much canvassed, and though not half weeded out as they ought to be, still pretty well selected. On the whole there is to be found among them more than an average amount of merit. But our mares are wofully neglected—sold abroad, and not half valued as they should be. Many a half-bred mare is a mine of wealth to a farmer, if she is only the *right* and not the *wrong* sort, and if he gives her the chance of a good stallion. I am more inclined to rely on finding in the progeny those good qualities which they would naturally inherit from the dam's side than from that of the horse. I have seen both half-bred and thoroughbred mares that threw good foals to various horses, but yet all possessing merit.

I should like to see two 50*l.* prizes given—one for the best

hunting mare, and one for the best hackney mare ; I would not debar the same animal from entering in both classes, because I think it possible that *one* mare may have such a frame and quality as would enable her to fulfil either purpose. I can instance one mare exhibited in the hackney class which gained the prize there, and was so superior to any shown in the hunting class that she ought to have carried that off as well.

This is a difficult class to judge quite fairly, for good old mares that have been much knocked about often appear to great disadvantage, and mistakes too have been made, and a prize improperly withheld, where the eyes have been injured by accident. Blindness must not of course be overlooked ; but a defect, the result of accident (if the fact be satisfactorily proved), ought not to disqualify. There seems now to be a reaction in horse-breeding, consequent on the high prices realized since the Crimean War. This is, therefore, a favourable moment for making an effort to improve our brood mares. From the returns in 'Weatherby,' the number of thoroughbred mares in England is about 2050, all of the highest lineage ; and the number of thoroughbred foals of 1860 was 1450 or a little more. The blood stallions advertised at from 50 guineas a mare down to 5 guineas, amount to nearly 300 ; there are as many more, known only in their immediate localities. From this it will appear that the fountain-head is maintained in its original purity, and much pains is expended in keeping it up.

With this advantage of pure blood it is the duty of the country gentlemen and farmers to keep up to the mark the useful classes of hunting and riding horses, as well as those adapted to harness and military service. As every day brings all parts of the world nearer to us, the long-established demand for our horses increases rather than diminishes, and every month records the shipment to distant countries of our most eagerly sought out sires and mares.

XXVII.—M. L. de Lavergne *on the Rural Economy of France since* 1789. By F. R. de la Tréhonnais.

A work on the rural economy of France written merely to array statistical tables, and describe the status of property, the mode of farming, and the various circumstances of climate, local wants, and traditionary customs of husbandry, would appear almost a work of supererogation after the admirable book published by M. de Lavergne in 1850, in which the rural economy of England, Scotland, and Ireland is contrasted with that of his own country. This book gives us a most complete account of the agricultural status, riches, and produce of France, as well as an elaborate

description of the various modes of farming, the laws of tenure, the customs of *metayage*, &c., &c., which are prevalent in that country. But M. de Lavergne reminds us that the object of his new book is not so much merely to describe French agriculture, but rather to trace the influence exercised upon that great interest by the period of violence and bloodshed, known by the name of the Great French Revolution, to which the date of 1789 is, with questionable propriety, applied. There are people who look back to that period as the spring of a new era of civilization and material prosperity: it was, then, an enterprise of no slight importance to examine whether that awful period was, in itself, attended with benefit to French society in respect to any of its interests, and particularly that with which we are more especially concerned, namely—Agriculture.

M. de Lavergne tells us that the selection of this subject was not due to his own initiative; it was the choice of that learned body the Academy of the Moral and Political Sciences, of which he is a member, and every one who is acquainted with this distinguished economist will readily acknowledge that a better pen could not have been selected for this important task; nor will his warning voice be otherwise than opportune if there is a danger of the same errors and excesses being repeated under the same strangely misapplied watchwords of glory and liberty!

It is then by no means irrelevant to the objects of agricultural progress, to review past history and point out the adverse or felicitous influences which great political changes have exerted upon it, carefully restricting ourselves in these pages to that one aspect of such events. That great epoch which abolished the feudal system, and wrought so many changes on the face of French society, naturally divides itself into two periods—the first comprising the enlightened administration of Malesherbes and Turgot under Louis XVI.; the other (and M. de Lavergne very forcibly draws the distinction), that period which was inaugurated in 1793 in the Reign of Terror, and prolonged with but little direct benefit to agriculture up to 1814.

The great and beneficial reforms made in the former period are hardly known and appreciated, merged and confounded as they generally are with the events of the revolutionary period. M. de Lavergne truly says, "Under the stigma of *Ancien Régime* two very different epochs are often confounded. The memory of Louis XIV. and Louis XV. deserves the severest judgment; but it is not the case with that of Louis XVI. That reign which so disastrously ended is, on the contrary, one of the most happy periods of French history, and the thirty-two years during which the *Restoration* and the Constitutional Monarchy of Louis Philippe lasted can alone bear a comparison with

that prosperous and peaceful period." Among the reforms accomplished under Louis XVI. may be cited the celebrated edicts which removed the last vestiges of serfdom, established free trade in corn and wine in the interior, and unconditionally abolished corvées, *jurandes*, exclusive rights relating to the preservation of game, to dove-cotes and open warrens. The abolition of tithes, although a measure of more questionable policy, at all events relieved landed property from a heavy direct impost, and stimulated the investment of capital in agricultural pursuits.

Agriculture felt the influence of this movement; and although its advancement was limited by the want both of capital and of modern scientific knowledge, still the mere removal of arbitrary barriers gave it a mighty impulse. Two most important achievements of French agriculture had been for some considerable time already realized—the introduction of the culture of maize, and the production of silk; but it was at this time Parmentier introduced and extended the culture of potatoes, and Daubenton brought into France the Spanish-Merino sheep. And now, with the hearty co-operation of the privileged classes, a new constitution had been framed conferring equal rights on all, and providing for the due administration of justice and finance, so as to give security to the person and to property.

M. de Lavergne thus sums up the benefits which the peaceful Revolution of 1789, voted by the States-General and sanctioned by the King, had secured to the nation:—"Behold," he says, "the tithes and feudal rights abolished. From that moment, all the consequences which such an act could have for agriculture, were secured. At the same time all burdens upon the land, in the shape of tolls and dues, were declared redeemable, the equal liability of all estates to public taxation was proclaimed. The other rights of the man and citizen, such as personal liberty, the right of acquiring property, the freedom of labour, liberty of conscience, liberty in speaking and writing, a voice in the imposition of taxes, and a share in the government of the country, were no longer denied. These are the conquests which have revived and truly bestowed fertility on the soil." To this must be added the law of the 28th September, 1791, which breathes the same spirit, and enacts as follows:—"1st. The soil of France is free like those who dwell thereon; consequently every landed estate can be subjected only to those usages established or recognised by the law, and to the sacrifices which may be required for the public weal, due compensation being in both cases previously agreed upon. 2nd. The landowners are free to vary as they think proper the culture and management of their land; to regulate their crops as they think fit, and to dispose

of their produce within the kingdom and abroad without prejudice to the rights of others, and in conformity with the law."

In order fully to appreciate the extent of these concessions it must be borne in mind that a most absurd system of commercial restrictions prevailed, not only as regards foreign exports and imports, but even in the intercourse between province and province within the boundaries of the kingdom. Any province could forbid the export of grain or cattle into another province; and it did not unfrequently happen that one part of the country rejoiced in the greatest abundance, whilst the very next province suffered the pangs of famine. The government could absolutely close or open the ports, fix the price of corn, and even regulate the cultivation of wheat, settling for the farmer the breadth of cereal crops he was to grow, and forbidding any modification of the then prevailing rule of husbandry. Hence fallows were restricted; a judicious rotation unknown; and the culture of wheat enforced with suicidal rigour, till the exhausted land could make no adequate return. The only rule then in use and consequently strictly enforced, was white crops and bare fallow. It was even forbidden to withdraw land from wheat cultivation by planting vines, without express permission to do so.

These ill-judged restrictions, which not only checked improvement but tended to create famine, were greater obstacles in the way of progress than the burden of tithes or the abuses of the feudal system.

Some partisans of the Revolution point, however, to one of its most violent acts, viz. the seizure and sale of the landed property of the nobles and the clergy, as having exercised a most salutary influence upon agriculture by causing a greater division of the soil.

M. de Lavergne examines at length this proposition, to which he rightly demurs; not indeed from a consideration of any evil effects arising from the division of property, but from the fact, that neither in this or in other respects did that measure of wholesale confiscation produce anything like the changes which are generally ascribed to it. In respect to church property, M. de Lavergne shows in detail that the net income of two and a half millions then derived from this source, and expended on the maintenance of the clergy, the exigencies of public worship, the repairs of ecclesiastical buildings, the education and maintenance of the poor, was not more than equivalent to the sum now charged upon the Consolidated Fund for those purposes, so that the nation is no gainer by the change. He also points out that the terms on which much of this church property was held, were such as to conduce to the development of agriculture on a large

scale, in a manner approximating to that system of leasing considerable tracts, which has exercised so important an influence on English agriculture.

M. de Lavergne is not disposed to consider an extreme division of landed property as an obstacle to agricultural progress, and we shall presently examine the arguments by which he attempts to establish his opinion ; but he justly describes the nefarious effects which resulted from a large quantity of land being suddenly thrown into the market.

In the first place, its value was depreciated to a ruinous extent ; next, the estates being subdivided were brought within the reach of small capitalists, who were tempted to embark nearly all their property in the purchase, leaving little or nothing to meet the expenses of cultivation. They generally gained little by exchanging their position as tenants for that of proprietors, for such a policy is calculated rather to divert capital into other channels than to increase the means applicable to the culture of the soil, and its adoption has produced the natural consequences. A wealthy tenant farmer is scarcely to be found in France ; but poor landed proprietors exist in thousands. The bane of French agriculture is that morbid ambition of the peasantry to possess land : this is the true cause of their poverty, and consequently of their imperviousness to the influence of agricultural progress. The savings of a life passed in sordid frugality and abject privations are commonly devoted to this object : if these do not suffice, to eke out the purchase-money, a loan is procured at the rate of 5 per cent., although the investment will not make more than 2½, or at the utmost 3 per cent. These results may be in the main traced back to that wholesale act of confiscation to which we have referred. M. de Lavergne demonstrates very forcibly that it was principally middle-size estates that were increased by the purchase of the so-called national property, and that the number of small estates has not so rapidly increased since the Revolution as some people have imagined. In 1789 Arthur Young calculated that the number of small estates comprised full one-third of the kingdom ; and Necker wrote at the same time, " there are in France an *immensity* of small rural estates." With all the subdividing tendencies of the laws of inheritance in France, it is not probable that the number of these small holdings have materially increased. This, no doubt, is owing to two causes : one is the stationary or almost retrograde condition of the population, in consequence of French families now-a-days rarely numbering more than one or two children. We have been told by a district magistrate (*juge de paix*) in Normandy, that within his recollection the number of births had diminished by two-thirds in his district, and consequently the population had

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shrunk in the same ratio; and the other is the system of giving adequate marriage-portions to daughters, without which they have little chance of finding suitors. It is easy to conceive that in such a state of society the accession of property brought by marriage goes far to counteract the laws of subdivision of inheritance, and on the whole that the number of small proprietors inclines more to diminution than increase at present.

It is generally thought that the equal division of property was only enforced by law after the Revolution. This is not correct: under the old régime the estates of the nobles were those alone entailed; the equal division of inheritance existed for the middle class and the people. The Revolution merely extended this law to all estates. M. de Lavergne greatly approves of this measure, and certainly adduces very cogent reasons to support his views; but this is a point, and perhaps the only one, in which we do not agree with him; and few who can appreciate the social and intellectual influence exercised by the aristocracy of this country will concur with M. de Lavergne on the subject of the privilege of primogeniture. We need only point to the efforts made by the large landowners of England to bring agricultural practice into unison with scientific discoveries by costly experiments, which they alone could afford to make, and by the happy results of which the agriculture of the whole world has benefited to a degree which it is difficult to realize. It would indeed be idle, when addressing English readers, to expatiate upon the advantages which all the institutions, nay, all the interests, of England have derived, and derive more and more, from the high status of her aristocracy. There is not a single page of English history in which the aristocracy are not associated with its glorious records; and although we are not prepared to combat M. de Lavergne's arguments in respect to the French aristocracy—who during the last few reigns previous to the Revolution were certainly more remarkable for their courtly and dissolute habits than their devotion to the public weal, and until the last few years never did anything to promote agricultural progress—yet we maintain that the two cases are by no means parallel, and that in England the law of primogeniture, by preserving the entirety of large estates, by concentrating the powerful means of wealth into the hands of intelligent, patriotic, and benevolent men, has been and is still one of the strongest bulwarks of English prosperity; whilst, on the other hand, one of the most fatal gifts of the Revolution, as regards the agricultural progress of France, was the law of inheritance. No proprietor can be certain that his estate will come into the hands of any of his children. Should he die before they are all of age, the law steps in and forcibly sells his estates, in order to divide the proceeds among them; or else the task of

subdivision may be too arduous to be amicably arranged, in which case the heirs agree to sell. With such a contingency staring him in the face, how can a prudent father of a family bring himself to attempt improvements of a permanent character upon his estate? Is it not much better for him to invest his money in securities more easily realized, and consequently more easily divided among his children? This sentiment goes so far, that it is a prevalent opinion among landed proprietors in France that all money spent in land improvements is inevitably lost.

Another great evil which modern enactments on the part of the Emperor have sought to remedy, is the existence of large tracts of land, mostly of excellent quality, remaining uncultivated, unenclosed, undrained, and consequently useless. These lands were peremptorily given to the parishes by the revolutionary power of 1793, even where the rights of private proprietors were clearly established: twelve millions and a half acres, or one-tenth of the whole territory, were thus snatched from cultivation and abandoned to waste and sterility.

The foreign wars and consequent conscriptions under the First Empire were hardly less hostile to agricultural progress than the excesses which preceded them. It is calculated that during the wars that raged between 1792 and 1800, no less than one million Frenchmen were destroyed on battle-fields and in hospitals! and from 1804 to 1815 the number that fell has been fixed by the most competent authorities at no less than one million seven hundred thousand.

Besides these dire influences, there were the foolish and mischievous enactments made by ignorant statesmen—strangers to the most vulgar rules of political economy. The abominable laws of *Maximum*, which professed to limit the price at which corn should be sold, were actually re-enacted in May, 1812, by a decree which made it a criminal act to speculate in corn, and fixed its price at 33 francs the hectolitre—about 76*s.* a quarter. Of course this law, like that of 1793, only led to a famine.

Another decree, dated 8th March, 1811, having for its object "*the improvement of flocks*," enacted that no breeder of Merino sheep should castrate any of his rams without the authorisation of an inspector; and it was further enacted that every breeder who used a cross should have all his male lambs castrated, under the penalty of a fine not less than 4*l.*, and not more than 40*l.*, to be doubled in case of a subsequent offence! M. de Lavergne justly observes that it is really astonishing that in the face of all these adverse circumstances and fearful calamities, the cultivation of the soil did not come to a standstill altogether. The only incentive to agricultural pursuits, in the midst of these difficulties, was the high price which all the necessaries of life long con-

tinued to command, as it is well known that corn fetched a famine price during the greatest portion of the revolutionary period.

A comparison between the agricultural and commercial status of France in 1789 and in 1815, clearly shows that that period has not only been a dead blank—a fearful halt in the march of progress, but comparatively a positive retrogression in every branch of the national wealth. According to Lavoisier,* and the trustworthy data given by Arthur Young, the total agricultural produce of France at the time the Revolution broke out, amounted to about 104,000,000*l.* sterling, equal to 4*l.* per head of the population. Chaptal, in his work entitled 'De l'Industrie Française,' published in 1818, after deducting the seed, the food of animals, and the other drawbacks usually allowed for in such estimates, states the total agricultural produce of France at about 120,000,000*l.* sterling, which would only give an increase of 16,000,000*l.* for a quarter of a century, and this increase, there is every reason to believe, was due solely to the Consulate. Neither the Republic nor the Empire added a jot to the agricultural prosperity of France. It is a remarkable fact, that the movement of the population followed the same ratio. The population of France, in 1789, was 26,500,000. In 1815 it was scarcely 29,500,000—an increase of only 3,000,000. This increase in the population, as well as that in the produce of the land noticed above, took place during the short respite of the Consulate. Thus, in the words of M. de Lavergne :—"The revolutionary fury and the ambition of one man had successively devoured the greatest part of that which the industry and labour of a great people had striven to produce."

With the restoration of the Bourbons a new era of activity and peaceful enterprise commenced, showing how elastic, how tenacious of life, is the prosperity of a country when it is based upon the resources of the soil. Notwithstanding the heavy burthen imposed by the conquerors of forty millions sterling as a war indemnity, and another forty millions sterling as a compensation to the exiled nobility, France had no sooner cast off the fatal incubus of ambition, than the natural resources of her soil, the energy and genius of her sons burst forth, under the protection of peace, justice, and security. From that period up to 1847, the public prosperity of France steadily and rapidly increased without any intermission, and especially from the year 1830, when a greater measure of liberty was meted out to the nation. "From that time," observes M. de Lavergne, "a fresh activity manifested itself by immense public works, which, executed this time upon all points of the territory, or nearly so, have left far

* 'Richesse Territoriale du Royaume de France.'

behind them everything of the kind which had preceded them. 78,125 miles of new roads were opened, numerous canals constructed, river-courses deepened and improved, harbours constructed or enlarged, 5625 miles of railway were opened, and 4000 more in course of construction. Owing to the constant progress in the means of communication, intercourses hitherto unknown have sprung up, the conditions of labour have been completely altered, production has attained a power which seems to baffle all obstacles; revolutions, wars, famines, epidemics, all these scourges, formerly so deadly, may now stay its progress, but can no longer stop its power, nor suspend its activity."

M. de Lavergne naturally divides this period into two distinct parts; the one extending from 1815 to 1847, the other running from 1848 up to the present time.

Any one who has watched the movement of this country with the slightest attention must admit that, though checks and interruptions may arise, permanent retrogression is now impossible, so powerful are the means now at the command of the community, and so general the enlightenment necessary to direct the use and application of these means. Yet, on a comparison between these two periods, the progress of agriculture will appear to have been most rapid during the former, although in the latter greater efforts at direct encouragement have been officially directed to the promotion of agriculture. This anomaly can be accounted for by a reference to several causes: some natural—such as the potato murrain, and especially the vine-disease, and the failures in the harvests of 1846, 1853, and 1855; others social or political. The concentration of labour in Paris and other large cities, caused by the gigantic buildings and other works carried on at the public expense, have contributed to withdraw from the agricultural interest both labour and capital. French agriculture has also to lament another scourge — the disease of silkworms—which has reduced by three-fourths the production of silk in the southern provinces.

The subdivision of property has also greatly increased of late—an evil by no means mitigated, as M. de Lavergne is inclined to believe, by the fact that each portion has increased in value, so that land-proprietors, although the owners of a smaller portion of land, are as rich, on the average, as they were before 1789, for the value of almost everything else around them has also increased in the same ratio.

It is scarcely possible to give anything like an accurate estimate of the distribution of land property before the great Revolution of 1789. All we know is that the Church owned about one-sixth of the territory, the State and the parishes another

sixth, and the nobles, the bourgeois, and the peasants, pretty equally divided the other half.

In 1815, after the Church had been robbed of her property, and the greatest portion of the aristocracy's lands had been brought under the revolutionary hammer, the territory was divided as follows:*—

21,456	families owning	an average of	2200	acres.
108,645	„	„	155	„
217,817	„	„	55	„
256,533	„	„	30	„
258,452	„	„	20	„
361,711	„	„	12½	„
567,687	„	„	7½	„
851,280	„	„	3	„
1,101,421	„	„	1	„

In all 3,805,000 proprietors, owning about 111,875,000 acres.

Since 1815 this minute division seems to have greatly increased. M. de Lavergne, from a careful examination of the Land-tax Schedules, at the present time thus describes the division of landed property:—

50,000 large proprietors	owning on an average	750	acres.
500,000 middle-class proprietors	„	75	„
5,000,000 small proprietors	„	7·5	„

In all 5,550,000 proprietors for about 112,500,000 acres. This extent of cultivated land, as compared with what it was in 1789, presents many a cheering sign of progress.

According to Arthur Young's calculations, slightly modified from other sources of information, the land in 1780 was thus distributed:—

Arable land	62,500,000	acres.
Gardens and orchards	3,750,000	„
Vineyards	3,750,000	„
Woods and forests	22,500,000	„
Meadows	7,500,000	„
Waste lands	25,000,000	„
Total	125,000,000	„

According to the last official statistics it is now distributed as follows:—

Arable land	65,000,000	acres.
Gardens and orchards	5,000,000	„
Vineyards	5,000,000	„
Woods and forests	20,000,000	„
Meadows	10,000,000	„
Waste lands	20,000,000	„
Total	125,000,000	„

* M. Rubichon, 'Du Mécanisme de la Société en France et en Angleterre,' p. 31.

Thus it would appear that the extent of waste lands has diminished by 5,000,000 acres, that of woods and forests by 2,500,000 acres, whilst the gardens and orchards have increased by 1,250,000 acres, the surface under tillage by 2,500,000 acres, the meadows by 2,500,000 acres, and the vineyards by 1,500,000 acres.

This, after all, as M. de Lavergne observes, is but a slow progress for so long a period. At this pace France would require two centuries to reclaim all her waste lands.

The progress accomplished in the actual cultivation of the soil, and the distribution and rotation of crops, is far more important, as may be seen from the following table:—

	1789.	1859.
Bare fallow	25,000,000 acres	12,500,000 acres.
Wheat	10,000,000 „	15,000,000 „
Rye and other grains	17,500,000 „	15,000,000 „
Oats	6,250,000 „	7,500,000 „
Grass and seeds	2,500,000 „	7,500,000 „
Roots	250,000 „	5,000,000 „
Divers crops	1,000,000 „	2,500,000 „
	62,500,000 „	65,000,000 „

A glance on those figures will show that the old system of bare fallow has receded by one-half, and the cultivation of roots has increased by 4,750,000 acres. Altogether the extent of land cultivated for fodder has increased by nearly 10,000,000 acres. This is a most encouraging feature, because it betokens a greater production of farm-manure and meat, the importance of which to agriculture is easily understood.

Together with a better rotation of crops, the yield has also increased. Formerly the average production of wheat did not exceed 9 bushels per acre, exclusive of the seed; now it reaches nearly 14.

All *industrial* crops have also greatly improved, both in yield and quality. Silk and rape have increased five-fold, wine has doubled, whilst the manufacture of sugar and that of spirits from beet-root are new creations.

From the foregoing causes, the value of the annual produce of the land in France may now be computed at 200 millions sterling—about twice as much as in 1789, and about 80 millions more than in 1815.

Knowing the gross produce, it is interesting to ascertain what can be now the net profit derived from the cultivation of the soil, and compare it with what it was in 1789.

Lavoisier says that in 1789 the net revenue of the landowners of France was about 24 millions sterling, which would not give quite an average of 4*s.* an acre for annual rent paid by the tenant.

Now the average rent cannot be estimated at less than 10*s.* an acre. At 33 years' purchase, or 3 per cent., these figures would fix the selling value of the land at not quite 7*l.* an acre in 1789, and 16*l.* at the present time. These figures would show that the rent and consequently the price of land have increased since 1789 at a greater ratio than the gross produce; but one of the causes that may explain this fact is no doubt the abolition of feudal rights and of tithes, and also the permanent improvements which have been accomplished of late years.

It remains now to ascertain what is the tenant's profit now, and what it was at the time of the Revolution.

It is generally found that the profit is proportionate to the working capital engaged in any undertaking. In 1789 the working capital engaged in agriculture was about one-half of what it is now, and may be calculated at 16*s.* per acre, including the woods and forests and the waste land, which comprised then one half of the territory. If we deduct that extent of land demanding little or no capital, we shall come to an average of 32*s.* per cultivated acre. This average cannot now be less than 32*s.* per acre of the whole territory, or about 2*l.* 8*s.* per cultivated acre.

Next comes the question of taxation. The land in 1789 bore the greatest part of the burthen of taxation; the budget, which amounted then to 24 millions sterling, drew from landed property at least 14 millions, including tithes. In our times, although direct taxation is a little diminished, yet all public charges, and the burthens on land among the rest, have been enormously increased. Formerly the duty on sales of land belonged to the lords; now it belongs to the state, and is six times more productive than it was in 1789, and altogether it may be safely assumed that French agriculturists pay twice as much as they did before the Revolution, tithes included. But on the other hand, it must be borne in mind that owing to the increased produce of the land, and the development of its resources, this taxation, though doubled in amount, is much less severely felt than it was in 1789. M. de Lavergne here very truly observes, that the ideas of 1789 have furnished France with the means of paying that enormous increase of taxation; but if they had fully been realised, there would not be any occasion for that increase.

The price of labour is another interesting question to investigate, in order to complete the comparison. Arthur Young estimates the average wages of labourers at the time of his travels at 19 *sols*, about 9½*d.* per day; it is now 1*s.* 3*d.* As the rural population of France is now the same in point of number as it was in 1789, there is probably a greater demand for labour, and consequently a greater number of days in which labourers are

employed: it may be assumed that the annual income of farm labourers has doubled since 1789. On the other hand, the price of the necessaries of life, except meat, being pretty much the same now as then, and the price of manufactured articles of household use and that of textile fabrics having considerably diminished, it may be inferred that the general condition of labourers has greatly improved in our times.

The following table will give a clear idea of the distribution of the gross produce of the land at the three periods of 1789, 1815, and 1859:—

	1789.			1815.			1859.		
	£.	*s.*	*d.*	£.	*s.*	*d.*	£.	*s.*	*d.*
Landlord's rent per acre ..	0	4	0	0	5	9	0	9	6
Tenant's profit	0	1	8	0	2	0	0	3	2
Working expenses	0	0	4	0	0	8	0	1	8
Land-taxes, tithes, &c. ..	0	2	3	0	1	3	0	1	9
Labour	0	7	9	0	9	6	0	15	11
Gross produce ..	0	16	0	0	19	0	1	12	0

M. de Lavergne draws from this table the following observations:—

"This progress suffices no doubt to excite within us a legitimate pride and a just confidence in the future; but we must never forget that it might have been at least twice as considerable, since we have wasted about the half of the time that has elapsed since the Revolution. A neighbouring country, in which the principles of 1789 have been, notwithstanding a few apparent exceptions, more anciently and more constantly applied than with us, has accomplished in the same time a progress much more rapid still. In 1789 the United Kingdom had 13 millions and a-half inhabitants; in 1856, the population had increased to 28 millions, without reckoning the millions of English-born individuals scattered in distant colonies and all over the world. The population of England has thus more than doubled, whilst ours has increased only by one-third. It has taken us 70 years to reclaim five million acres of waste lands, suppress half of our bare fallows, double our agricultural produce, increase our population by 30 per cent., wages 100 per cent., and rent 150 per cent.! At this rate we should require three-quarters of a century more to reach the point of prosperity which England has already attained."

Such is the substance of what M. de Lavergne modestly calls the "Introduction" to his book, but which must be considered as the very pith of the work itself. The remaining pages are filled with the most graphic descriptions of the various parts of the French territory, under their multifarious and varied aspects as regards topographical features and climate. In that detailed

examination of each well-defined region of France, our author defines the share that each contributes to the statistical figures we have given above. For a country like France, such a special examination is indispensable to convey an idea of the variety of its climates, local requirements, usages, wants, and resources. The Southern Provinces, bathed by the blue Mediterranean, bear no resemblance whatever to the northern departments bounded by the stormy waves of the English Channel and the Atlantic Ocean. An equally striking contrast exists between the banks of the Rhine and the Pyrenean regions—between the east and the west—the centre and the frontier. There are, indeed, few countries in the world where so little analogy exists between their component parts, and where perhaps material prosperity is distributed so unevenly, as in the French Empire. It is through this heterogeneous mass that M. de Lavergne, with all the charms of his graphic pen, lucid diction, and clear exposition, takes his reader, relieving his attention from dry statistical facts by interesting allusions to curious historical reminiscences, pictures of scenery and manners, portraits of men, narratives of travelling incidents—in fact, everything that can make his book instructive and entertaining in the highest degree. This work is at once a text-book for the economist, a most accurate travelling guide for the tourist, a pleasant pastime for the idle, and a valuable record of the most accurate statistics that have ever been published on the territorial riches and resources of France.

Having thus taken a primary survey of the history of French agriculture through the troubled times of the revolutionary era, we will now examine that part of M. de Lavergne's book which describes the present state of agriculture as displayed in the varied features of the six divisions into which he has parcelled the whole territory of France, from a consideration of the natural affinities of the districts thus grouped together. These divisions are as follows:—

1. The North-Western, comprising the 15 departments into which the ancient provinces of Flanders, Artois, Picardy, Normandy, and the Isle of France were divided.

2. The North-Eastern, comprising the 15 departments, formed out of Champagne, Burgundy, Franche Comté, Lorraine, and Alsace.

3. The Western, comprising the 14 departments substituted for the provinces of Touraine, Maine, Anjou, Britany, Poitou, Saintonge, and Angoumais.

4. The South-Eastern, including the old provinces of Lyonnais, part of Burgundy, Forez, Dauphiny, Vivarais, county of Avignon, Lower Languedoc, and Provence, now split up into 15 departments.

5. The South-Eastern, formed of the ancient province of Guyenne, with part of Languedoc, and the two small provinces of Bearn and Roussillon, now comprised in 14 departments.

6. The Central, composed of Sologne, Berri, Nivernois, Bourbonnais, Auvergne, Velay, Gevandau, Masche, Limousin, and Perigord, the whole being divided into 13 departments.

These six divisions are pretty equal in respect of area, but in that point alone, as the following Table will show :—

	Acres.	Population in 1856.	Population per 250 Acres.	Amount of Government Taxes paid in 1857.	Average per Acre.	Average per Inhabitant.
				£.	£. s. d.	£. s. d.
1. N.W. division . .	21,413,270	9,310,452	109	27,586,835	1 7 6	2 19 2
2. N.E. ,, . .	22,453,250	5,512,648	61·37	8,764,780	0 19 2	1 12 0
3. W. ,, . .	22,771,170	6,416,477	70	8,585,236	0 18 8	1 6 9
4. S.E. ,, . .	22,860,427	5,818,129	64	9,173,274	1 2 0	1 15 1
5. S.W. ,, . .	21,971,125	4,753,116	54	6,298,036	0 14 8	1 5 0
6. Central ,, . .	21,106,985	4,228,542	50	4,233,688	0 10 0	1 0 0
	132,576,227	36,039,559	Average per Acre. 0·27	64,641,849	Average 1 2 0	Average 1 16 0

Here we see at a glance wide differences in population, and wealth as indicated by taxation, differences for which we must seek an explanation from an endless variety of local peculiarities, among which, apart from the quality of the soil, the stimulus given to natural resources by markets, means of communication, climate, education, and civilization must not be overlooked. A rapid sketch of these peculiarities will suffice to show that the empire of France, which on the map appears so compact, so homogeneous, so well defined by seas, rivers, and lofty chains of mountains, is in reality composed of heterogeneous parts in every possible respect. Whether we look at the topographical features of the country, and its varieties of climate and produce, or to the striking contrast presented by the several races from which its inhabitants have sprung, their divers dialects, ethnological peculiarities, diversity of tastes, habits, wants, and traditions (each at least as distinct and easily recognized as the peculiarities which in this country betray the Irishman or Scotchman), we cannot wonder that there should exist so marked a difference in the respective prosperity of these divisions, governed though they be by the same laws, and having access to the same advantages of education and social enlightenment.

Among the aids to natural fertility few are of more importance than the means of communication afforded by public roads and railways. The following Table will show how unequal is the distribution of these advantages over the French empire.

In 1857 the extent of public highways regularly kept in repair amounted to 100,207 miles, canals and navigable rivers 8457 miles, railways 5516 miles, divided as follows:—

	Roads.	Canals and Navigable Rivers.	Railways.
	Miles.	Miles.	Miles.
1. N.W. district	25,000	2106	1572
2. N.E. ,, ...	16,990	1685	1281
3. W. ,, ...	18,988	1645	677
4. S.E. ,, ...	12,471	1468	914
5. S.W. ,, ...	14,179	1435	622
6. Central ,, ...	12,579	118	450
	100,207	8457	5516

This Table shows very forcibly that the most prosperous districts are those which are the better provided with means of communication.

The first division, the North-Western, is not only remarkable for its industrial prosperity, comprising as it does the most important manufacturing districts, but for the unrivalled excellence of its agriculture. Although it represents only the sixth part of the territory, it contains more than the fourth part of the population, and contributes nearly half the taxes of the nation, without reckoning the heavy municipal dues of the department of the Seine. If any proof were wanted that the riches of nations directly spring up from agricultural prosperity, the statistics of the North-Western districts of France would amply suffice to establish the point.

If we begin with the northern extremity, we here find Flemish agriculture quite at home in these comparatively recent conquests of Louis XIV. Flanders was the cradle of European agriculture. "In these rich plains originated (to quote M. Lavergne) that alternation of crops which has since been adopted in England and then in France, and is destined to make the circuit of the globe."

"The origin of this discovery—most precious to mankind, inasmuch as this alone can enable us on a given space to feed an indefinite population—is lost in the obscurity of the middle ages. Virgil, it is true, alludes to this practice, '*alternis requiescunt fetibus arva;*' but the Romans do not appear to have carried it out on a large scale. Its real development is due to the requirements of great towns, such as Ghent and Bruges, when at war with kings and princes. The ancient as well as modern Flemings owed much of their vigour to a generous diet; meat and beer made them what they were, and their chiefs often belonged to the guild of butchers or bakers."

This part of Flanders exhibits also the happy results of liberal political and social institutions. In the words of M. Lavergne: "In 1789 the department called Le Nord had already one inhabitant to every 2½ acres, that is to say, was at least twice as populous as the rest of France. M. Cordier justly remarks in his 'Agriculture of French Flanders,' that this country owed its wealth much more to its sound political institutions than to the fertility of the soil. Louis XIV. himself, after his conquest, respected these ancient liberties. This district, which had for centuries been emancipated from feudal burdens and indirect imposts, was still in 1789 governed by home-appointed unpaid magistrates. Rural districts, as well as towns, had the right and habit of undertaking public works; private companies were formed when required; and certain voluntary associations for reclaiming bogs and swamps, called *Watteringues*, flourished under a system of management which we should do well to imitate at the present day."

Arthur Young (an authority often quoted by M. Lavergne, as every Englishman will observe with pride and satisfaction) remarked in his tour, that the line of demarcation between French and Flemish husbandry followed precisely the line of the *ancient* boundary of the two countries. The difference did not depend upon the soil, for a finer plain can hardly be found than that which extends, almost without interruption, as far south as Orleans. It was despotism on the one side, with poverty-stricken neglect and a detestable system of corn-crops and fallow; and on the other freedom with a soil that never knew and never needed rest.

Even at the present day Flemish rotations are much more largely diversified than those practised in England, thus indicating a greater advancement in agricultural science; and nothing can exceed the perfection of the means used by Flemish farmers to restore to the soil those elements of fertility which their heavy cropping has withdrawn from it.

The principal feature of the agriculture of this division is the cultivation of beetroot as raw material for the manufacture of sugar, which has taken a most wonderful development—a sure test of its success. The department called *Le Nord* alone contains no less than 150 sugar-mills out of a total of 350 for the whole of France. This branch of industry has exercised so great an influence upon the agricultural production of the district, that in the town of Valenciennes a triumphal arch was erected in 1853 on which the following inscription is engraved: "*The growth of wheat in this district before the production of beetroot sugar was only* 122,569 *quarters, the number of oxen* 700*; since the introduction*

of the sugar manufacture the growth of wheat has been 146,180 *quarters, and the number of oxen* 11,500."

It must not, however, be overlooked that this agricultural prosperity is accompanied by a very serious drawback—over-population, which, according to M. Lavergne, "is not a necessary consequence, but a natural concomitant of small occupations." The excess is estimated at one-fourth, or even one-third of the whole population. Even M. Lavergne is driven to seek for some economical, not arbitrary, limit to the subdivision of holdings, and hints that hired farms might, with probable benefit, comprise a minimum of 25 acres, and properties held by the owner of 12 acres. It must not be overlooked that this over-population has arisen in a district where thriving and increasing manufactures have provided a considerable outlet for the surplus increasing rural population.

Among the interesting provinces comprised in the North-Western district is Normandy, so closely allied to England by the ties of race and history, and hardly less so by its scenery and pastoral features. "If," says M. Lavergne, "I were asked which is the most happy and prosperous part of France, I should without hesitation point to Normandy;" and yet we here find the strange anomaly of a decreasing population, and most impervious obstinacy in rejecting almost all agricultural improvement. Normandy is the land of meadows and pastures, one of the dairies of France; another of its distinguishing features is its breed of merino sheep, which of late has been most successfully crossed with the Leicester. Paris is largely supplied by its poultry, eggs, &c., which also make their way into the London market.

The system of tenure here in use is that of long leases; there is scarcely a single instance to be found of *métayage*, which is so prevalent elsewhere, especially in the southern provinces. The average of wages for agricultural labour are about 9*s.* 6*d.* a week.

2. North-Eastern Division.

This region comprises at least two most interesting provinces, Champagne and Burgundy: names not only familiar from their connexion with famous wines, but also illustrious from their historical associations. Nothing can exceed the contrast that exists between the North-Western region and this. Besides the great difference which, on a reference to the foregoing tables, will be noticed in the number of their inhabitants, and the amount of revenue they pay to the public exchequer, they are still more remarkably distinguished by the topographical aspect of the

country and the nature of the soil. "Instead of those vast plains softly inclining towards the ocean," says M. de Lavergne, "this North-Eastern region consists pretty much of a confused heap of hills and mountains, the ranges of which cross each other in all directions, and some of which rise to rather a high elevation. There are few towns and many forests, but an industrious population redeem by their activity the shortcomings of the soil."

The ancient province of Champagne, in an agricultural point of view, is as uninteresting as any barren desert can be. Of the four departments into which it is now divided, viz. the Ardennes, Aube, Marne, and Haute-Marne, the latter alone presents some patches of fertile soil. Everywhere else a barren surface prevails, which may be described as sterile grit, chalky tufa, or schist, upon which vegetable and animal life is so poor and stunted as to have drawn upon this province the opprobrious appellation of *Champagne Pouilleuse*, the meaning of which epithet we shall leave our readers to discover for themselves. At an early epoch these dreary wastes presented an attraction to St. Bernard and his followers, the founders of the Abbey of Clairvault, the head of eight hundred kindred monasteries. The monks were everywhere the best and earliest patrons of agriculture, the Counts of Champagne were kindly rulers, and this poor province enjoyed comparative prosperity; but then the English wars depopulated the country, and next the curse and blight arising from direct dependence on the French crown fell upon the land. Before the Revolution its poverty was notorious. Arthur Young's calculations show an average rent of 4 francs and gross produce of 12 francs per acre throughout the province. The misery of the people, due as much to the government as to the soil, was heartrending. The Ardennes were at one time covered with a dense forest, numerous patches of which are still extant. There are no natural pastures to be found except in the bottom of the valleys; and from want of staple soil or means of irrigation it is next to impossible to create them. Rye is the principal cereal grown, for it is the only one that can be obtained with any advantage. Where the culture of wheat is possible, the yield rarely exceeds 12 bushels an acre. The basins of the rivers Seine, Marne, and Aube alone form brilliant exceptions to this sombre aspect, from their luxuriant fertility.

But all this desolate and barren character which prevails over the greater extent of Champagne is most abundantly compensated by the sparkling produce of its famous vineyards. These, though limited in extent to about 150,000 acres, produce an average yearly return of nearly two millions and a half sterling, or about 16*l*. an acre.

"Champagne," says M. de Lavergne, "exhibits a rural organi-

zation which is found in many other parts of France, but which is nowhere so strongly marked as here. There are scarcely any isolated homesteads. The farm-houses are grouped in villages sometimes very distant one from another. The land nearest to these villages is let at an excessive rent; whilst the more distant fields, requiring expensive transport, are much less valuable and yield less produce. This arrangement, so disadvantageous to cultivation, is explained in many instances by the want of water; in others it owed its origin to the necessity of self-defence. This has been the favourite route of the most important invasions which have menaced our national independence, from the time, nearly fifteen centuries ago, when Attila was here defeated by the Franks and the Romans. These historical reminiscences reflect a gleam of light over this organization, which is so defective in an economical point of view. The richer lands are afflicted by another evil, that of subdivision.

"The interior of these villages presents a curious spectacle of rural life and activity, which extends even to the suburbs of the more important towns. At dusk, the cows are seen entering from all sides on their return from the fields, and slaking their thirst at the public drinking-places. At dawn, every morning, is heard the horn of the herdsman of the commune, and at the well-known sound from each door issues a small detachment of sheep to join the general flock. At the time of harvest cartloads of wheat and oats arrive from all points of the horizon, and numerous open barns disclose their close-packed sheaves. Ploughmen and vine-dressers start together and return together from their labour. This living in common has its advantage: if it checks rapid progress, it likewise prevents retrogression. The whole village moves with a nearly even step, and there exists between the representatives of various occupations a perpetual comparison which keeps up healthy emulation."

The greater part of Burgundy, comprising the departments of Yonne and Côte d'Or, with Ain and Saône et Loire, belongs to the South-Eastern Division, and is especially remarkable for its unrivalled wine. The principal vineyards lie on a low range of hills, called the *Côte d'Or*, which extends from Dijon to Beaune. It is on these slopes that Chambertin, Nuits, Romanée, and Clos Vougeot are situated.

Next comes Franche Comté, the half of which extends over the slopes of the Jura mountains. The principal agricultural feature of this district is the rearing of cattle and the production of cheese. The system known by the name of *fruitières* has been established over all the hilly districts. It is an imitation of the associations so prevalent in Switzerland for the manufacture of cheese.

The extreme division of property, and the consequent small number of cows owned by each tenant or proprietor, render it an impossibility for any single farmer to attempt making cheeses which require as much as 60 gallons of milk at once. Hence the necessity of association. A *fruitière* is then a company of small farmers, sometimes fifty or sixty in number, who carry all the milk from their cows to a central establishment, where it is manufactured into cheese, and where the produce is divided according to the quantity of milk contributed by each associate.

3. Western Division.

Leaving the extreme eastern limits, with their Alpine horizon, we now come to the opposite region, bordering on the Western Ocean. This division comprises all the remnants of the old Celtic race, displaying still, in the midst of modern civilization and refinement, much of that sturdy tenacity of purpose, earnestness of sentiment, indomitable clinging to old usages and traditions, which so eminently characterised the Celtic family. It is impossible to utter the names of Britanny, Anjou, Poitou, Vendée, without kindling vivid recollections of deeds of valour, fidelity, and heroic martyrdom on behalf of the most lofty principles by which society is upheld.

The admirable resources of that part of France, its mild climate, the natural fertility of its soil, its peninsular formation (jutting as it does far out into the Atlantic, which skirts two-thirds of its boundary), the stately Loire, whose broad stream intersects it from east to west like a huge artery, diffusing in its course the elements of life and activity: all these advantages, united to the sterling qualities of its inhabitants, seem to vindicate for it a higher position than that of third in rank among the six regions of France for wealth and prosperity. M. de Lavergne explains this anomaly. Previous to 1789 it was—that which it bids fair to become again—one of the most flourishing regions of the whole country. But the revolution of '93 kindled all over its hitherto bright and happy extent one of those terrible social conflagrations which destroy and raze to the ground every element of wealth, the embers of which, long after it has been extinguished, still smoulder beneath the ashes.

The disasters of the French republican era, in fact, dried up for half a century all those natural resources in which this ill-fated district abounds. No wonder, then, it should appear to a disadvantage in comparison with other more favoured parts of France. But M. de Lavergne assures us that for the last twenty years a great improvement has taken place. "No part of France," he says, "presents a greater show of industrious activity and increasing

prosperity. The North-Western Division itself, the privileged region, does not move at a quicker rate. There prosperity has reached a point whose every step in advance becomes more difficult to achieve; whereas the Western District, less rich by two-thirds, is full of youthful energy and hopes of future prosperity."

The main feature of this part of France is undoubtedly the valley of the majestic river Loire, of which M. de Lavergne gives the following *tableau* :—"The Valley of the Loire is justly reputed as one of the finest countries in Europe. From Orleans to the sea, a distance of nearly three hundred miles, stretches a long plain of alluvial soil, reclaimed by human industry from the stream, which often essays to regain its ascendency. These marvellously fertile lands, like others of this class, are in the clutches of petty owners. Divided and subdivided as they are, they sell as high as at the rate of 160*l.* per acre, and have the appearance of garden-culture. A multitude of small farmers, who find a ready market for their produce in the towns that crown its banks, inhabit a crowd of hamlets and villages built on the slopes of the hills or on the very banks of the river, under the protection of ancient causeways, which may be traced back to the time of Charlemagne. Generally, the Loire flows lazily over its sandy bed, or forms new channels without detriment to its embankments; but occasionally the stream, swollen to a mighty flood, sweeps over or undermines these massive barriers and overwhelms both crops and dwellings. But the soil is so productive, the climate so genial, the peasantry so pertinacious, and a market so sure, that scarcely have the waters disappeared when the victims of the flood again set to work, and in a short time no trace of the devastation remains." After describing the 250,000 acres of vineyard, similarly subdivided, which cover the chalky slopes on either bank, M. de Lavergne continues: "Add to this multitude of vine-dressers and market-gardeners who throng its banks the movement on the river itself, the numerous barges propelled by oars or sails which traverse its surface—Gaze in every direction upon those long vistas of the broadest valley in France, with its beautiful sheet of water, its groups of islands, its masses of verdant trees. . . . . Cast over this scene, so graceful and so grand, so lively and so calm, a hazy sky, a serene light, a balmy air, and you will understand why this country, so well calculated for the habitation of man, has received the appropriate name of the Garden of France. Five hundred thousand souls live there upon an extent of only 500,000 acres, and are pretty equally divided between town and country."

Another feature of singular interest and beauty may be added to this description, in those graceful châteaux which arise at

every bend of the smiling valley. These abodes of the ancient nobility of France, whether they now appear as ivy-clad ruins, or in their robust solidity display the traces of time without its decrepitude, and still harbour in their stately halls the sons of the ancient proprietors,—or whether the hand of modern restoration has combined the comforts of the present day with the stately magnificence of the feudal ages,—these châteaux are alike attractive from their picturesque outlines and the reminiscences of the past which they awaken.

4. South-Eastern Division.

We now reach another region, as distinct from the last in respect to climate, race, language, traditions, as any two European provinces can be. Like the Western Division, the chief topographical feature of the South-Eastern is a great valley, that of the Rhone. In an agricultural point of view, it holds only the fourth rank, but in general prosperity it is the second. The fact of its comprising such cities as Lyons and Marseilles, besides Saint Etienne, Nismes, Montpelier, Avignon, Grenoble — the well-known centres of French commerce and enterprise—easily accounts for this.

Beginning with its most northern province, now the department of Ain, at the foot of the southern extremity of the Jura, we find there a remarkable mode of cultivating clay-lands which is happily unknown in this country. In the ancient principality of Dombes (the modern district of Trevoux), the soil is composed of a stiff and most impervious clay. This circumstance led, before the introduction of modern drainage, to a peculiar mode of management. The country is covered with artificial dams to hold up the water in ponds or meres. These meres perform a double office: they breed fish, and by their deposits enrich the soil. Every third year the water is drawn off, the fish are caught and sold, the land cultivated for one season, and then again abandoned to the waters. There are 50,000 such meres, covering 50,000 acres; but this curious rotation is now going fast out of favour, chiefly in consequence of the unhealthy influences which it creates.

It is in a more southern part of this region that the cultivation of mulberry-trees for the production of silk chiefly flourishes; and although attempts have been made to introduce this branch of industry in many parts of France, and especially in Dauphiny, it is only in the Cevennes on the right bank of the Rhone that it has been attended with a full success. In 1789 the annual produce of the mulberry districts was about 6000 tons of cocoons, worth 600,000*l.*; in 1853, it had risen to 25,000 tons, worth

more than 4,000,000*l.* sterling. Since that year, a mysterious disease has considerably lessened that amount, and, although the price of raw silk has risen in consequence, the yearly loss to mulberry growers cannot be less than two millions sterling.

Besides the mulberry-tree, this region boasts of the olive-tree and the madder, which can only flourish in the warm climate of the south. In some favoured spots—in sheltered valleys, for instance, enjoying the double advantage of a hot atmosphere and a plentiful supply of moisture—the soil is so fertile, Nature so bountiful, that several crops are gathered every year. It is not rare to see in the same field mulberry-trees cultivated, around whose lower branches the vine entwines its richly-laden boughs, whilst beneath this luxuriant canopy heavy crops of wheat, roots, vegetables, madder, tobacco, &c., are gathered in endless succession.

Farther south comes Provence, with its tropical climate, where palm and orange trees grow in the open-air, and spring seems perpetual, especially in the department of Var. There, in a south-westerly direction, we meet the rich plains of Nismes, Montpelier, Narbonne, and Beziers, no less interesting to the agriculturist than to the antiquary and the artist. But if the southern portion of the South-Eastern Division of France is so remarkable for the advantages it derives from its climate, it has also to contend with its deadliest foe—water. A vast extent of territory is completely sterile and desert-like for want of it, and another part is periodically ruined by the devastation of mountain-torrents, which denude vast tracts of land of their vegetable soil, and sometimes transform luxuriant valleys into bleak and desolate solitudes. All travellers to Marseilles have remarked, after passing the old Roman city of Arles, the barren desert called La Crau, consisting of 30,000 acres, where there is to be found neither a bush nor a house, nor a blade of grass, except in winter, when half a million sheep, descending from their summer pastures on the slopes of the Alps, come to be fed upon a tiny grass that grows under the stones which cover this dreary waste. Out of 8,750,000 acres comprised in the four departments into which Provence is now divided, there are only 2,000,000 under cultivation; 1,200,000 are in woods, 500,000 in natural grazing-land, and the rest is a wilderness, the desolation of which cannot be exceeded.

5.—South-Western Division.

We leave the snowy peaks of the Alps and the blue waters of the Mediterranean, and we now perceive on our left the lofty summits of the Pyrenees, and in the extreme west the waves of the Atlantic Ocean. Two-thirds of this division consist of

mountains; the remainder forms a beautiful plain, watered by the Garonne, and intersected by the famous Canal du Midi. In respect of population, agricultural and industrial prosperity, notwithstanding the many natural advantages which it possesses, this is one of the poorest districts in France. M. de Lavergne explains this inferiority from historical deductions, which we cannot follow out in the pages of this Journal, though their cogency is beyond a doubt. Out of nearly 22,000,000 acres, this division has no less than 5,000,000 acres of uncultivated land, a large proportion of which might be reclaimed with a moderate supply of capital and labour. Such is the marshy plain that extends from Bordeaux to Bayonne, measuring nearly 2,000,000 acres. There are, besides, 3,000,000 acres in woods and forests.

It is especially in this part of France that the system of tenure known under the name of *métayage* most generally prevails. This system, as is well known, consists in the tenant paying his rent in kind instead of money. The landowner provides the land and buildings, and sometimes the horses, implements, and stock under certain stipulations; and both equally divide the produce whatever it be. When a métayer enters upon his farm an account is drawn of everything he finds there in the shape of implements, horses, and cattle, and when he leaves it he must hand over to his successor exactly the same stock or its equivalent. In fact, the tenant gives his labour and provides half the capital or its equivalent in stock, the landlord provides the land and his share of the capital or its equivalent in stock. In some parts of Anjou, Touraine, and adjacent districts, this system proves a real advantage to both parties, because both tenant and landlord have capital and intelligence, both are eager to increase their produce by adopting a progressive system, and especially by liberally manuring their land. They work together, the landlord with his brains and money, the tenant with his activity and experience; but in the south-western division this system, instead of being beneficial to the landlord, is a dire necessity which he is obliged to bear, but from which he would gladly escape. M. de Lavergne truly says that *métayage* has two aspects—the one bright and prosperous when the common interest and the private interest of both parties are presumed to coincide, and each seeks to increase his share by increasing that of the other; the other aspect—and this is the one that prevails in the south-western region—where each party seeks to increase his share by curtailing that of the other. This unhappy feeling gives rise to all sorts of injustice and robbery. When thus carried on, this system is no longer an association—it is antagonism in its very worst form.

In 1856 there were 75,000 acres of land drained in France, and out of that surface only 5000 belonged to the south-western division, and yet the nature of the soil is eminently argillaceous, and there is no part of France that would derive greater advantages from drainage, on account of the sudden and heavy falls of rain, which at times deluge the land without finding any other means of escape than a slow evaporation.

The science and practice of agriculture have scarcely advanced since the Romans; the only rotation known is the biennial wheat and dead fallow; the plough used is still the rude *aratrum* of the Romans, and every other means and practice is equally primitive and inefficient. Of course, this does not apply to the neighbourhoods of Bordeaux and Toulouse, where the cultivation of the vine, which forms the staple produce of the land, is carried on with all the appliances of modern science and mechanical skill. This, indeed, is the principal source of the riches of that district, which comprises alone fully one-third of the vineyards of France. The department of the Gironde alone contains no less than 312,500 acres of vines, yielding an annual produce of more than 55,000,000 gallons of wine. It is a remarkable fact that it was during the English rule in Guyenne in the fourteenth century that the exportation of Bordeaux wine assumed its principal development. Froissart, in his 'Chronicles,' mentions an English fleet of 200 sail which went every year to Bordeaux to be freighted with wine for the English market.

Of these vineyards the most celebrated, because the most valuable, are those of Medoc, a narrow strip of land situated between the Gironde and the sea. These vineyards cover an extent of 50,000 acres, out of which 12,500 only are of superior growth. It is in that small district that the celebrated Château-Margaux, Laffitte, and Latour, together with their lesser but still brilliant satellites Brannes-Mouton, Léoville, Larose, &c., are situated. The high price of these wines is not solely due to their excellence, but also to the excessive cost of their culture and preparation. The average produce of Medoc exceeds 800,000*l.*, which gives about 16*l.* an acre. The plantation of new vineyards is also very costly; it takes four years before any produce can be gathered, and then the total amount of disbursements has reached at least 6*l.* 10*s.* an acre, besides the rent. Of late years the disease known under the name of *Oidium* has greatly diminished the produce both in quantity and quality.

6.—Centre Division.

We come now to the last and poorest region in France. It comprises the desolate Sologne and the mountains of Auvergne and

Limousin. Half its surface, and that the most prosperous, consists of mountains; the rest is a barren plain without any large valleys, such as those of the Loire, the Rhone, and the Dordogne, which in every other division of the country distribute that wealth, cheer, and prosperity, which seems to be borne along with the broad stream that flows in their bosoms.

The plain of Sologne contains 1,000,000 acres, and only 80,000 inhabitants, or only 8 per 100 acres. The Emperor of the French has taken in hand a large tract of the most desolate portion of that desert, and is improving it by means of the most costly appliances. A few private individuals have also attempted to reclaim other patches of it, with indifferent success.

Near Sologne is the old province of Berri, which has preserved all its ancient rural organization. Nearly all the farms are held under the system of métayage; but, as the land is in the hands of very large proprietors, who have lately devoted their intelligence and ample means to the progress of agriculture, they are accomplishing wonders, and making a radical change in the status of that province. To name such men as the Marquis of Vogüe, of Chelmsford celebrity, the Duke of Mortemart, the Prince of Chalais, the Duke of Maillé, the Prince d'Arembert, M. Lupin, the Trappist Fathers, &c., is sufficient to give an idea of the progress that is going on. "Owing to their united efforts," says M. de Lavergne, "the province of Berri will certainly one day rival our best provinces. It has doubled its produce within the last twenty-five years, and it may double it again within a shorter period." It is in this district that the most important and costly introduction of the Southdown breed of sheep has been made, and where it has best succeeded.

Such are the principal features of this admirable book. However tempted we may be to follow our author in the interesting details of each province, to give an outline of his graphic descriptions, to borrow from his inexhaustible lore of historical, legendary, and economical illustrations, we feel that we have already exceeded all reasonable limits, and must now bring our review to its conclusion. M. de Lavergne seems to have framed his work after the model of Arthur Young's celebrated Travels. The faithful descriptions of that eminent agriculturist form, indeed, a most admirable test for estimating the present state of French agriculture. The book, therefore, may be looked upon as the continuation, or rather the complement, of Arthur Young's Travels, and is the more welcome to the statistical student as it is the only one of the kind that has been published since the times of our English agricultural tourist. We trust we have said enough of its singular merits to induce all those who can read

the French language to procure the book itself and read it through. Let no one be deterred from doing so by its forbidding title, as we have rarely seen dry statistical facts and figures comprised in so alluring a form, and interspersed by so many entertaining details and pictures of scenery, manners, customs, &c. In one word, M. de Lavergne has written a book which has its place everywhere: in the study of the learned, in the boudoir or drawing-room of the wealthy, and especially in the travelling-bag of the tourist.

Norwood.

MISCELLANEOUS COMMUNICATIONS AND NOTICES.

1.—*On the Use of the Reaping-Machine in a Wet Harvest.* By the Right Hon. J. Evelyn Denison.

(Extract from a Letter.)

This year (1860) I had a large and heavy crop of wheat knocked down flat *and much twisted about*; my bailiff took off all the appliances from my machine (Wood's combined mower and reaper) for reaping, and some indeed of those used in mowing grass; he even took off the wheel on the side farthest from the horses, and allowed the knives to rest only on a shoe which travelled on the ground: in this way he passed the knives under the wheat, cut it, and allowed it to drop as it was cut.

The machine could only work one way against the inclination of the crop, so that time was lost in returning across the field idle; but better and cleaner work was made than could have been made by hand, and at a considerable saving of expense.

The success of this operation seems to be an exception to the general rule. I hear generally that reaping-machines did not succeed this autumn: it might, therefore, be some advantage that this success and this mode of using the reaper should be made known through the pages of the Journal.

The experience which I have had for the last two years of Wood's combined mower and reaper is much in its favour. I have cut all my clover and grass crops, as well as my corn crops—wheat, barley, oats, and beans—with this machine.

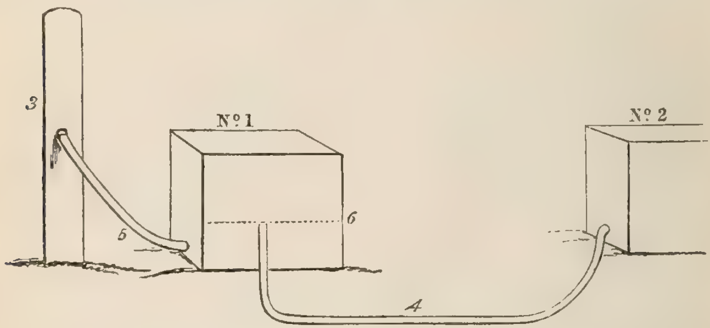
Ossington, 4*th Dec.*, 1860.

2.—*Soluble Food for Stock.*

To the Editor of the Journal of the Royal Agricultural Society.

Sir,—If you think the following plan worth a place in the Journal, I shall feel obliged by its insertion. Knowing well the advantage of giving a jaded horse a drink of meal and water, I concluded it would answer equally well to keep my water-trough in the farmyard continually supplied with any kind of meal that happened to be in readiness—such as rape and linseed cakes in powder, ground beans, barley, &c. Water is a powerful solvent, and the nutritious properties contained in the meal must necessarily be found in a state

of solution and available for the stock of all kinds drinking at the trough. My water-troughs are unfortunately too shallow to allow the plan to be thoroughly carried out, and the pipe conveying the liquid-food from the pump-trough (No. 1) to the yard-trough (No. 2) is too small in diameter to receive anything but pure and unmixed water. Hence I have not been able to fairly try my plan; at the same time I am fully satisfied of its utility. I send you a rough plan, not exactly of my own troughs, but such as I think they ought to be, and as I hope one day to make them:—



No. 1 is the water-trough nearest the pump, into which the meal should be first received; it should always stand half-full of water.

No. 2. Farmyard-trough, containing the meal and water, at which young and old stock drink daily.

No. 3. Pump.

No. 4. Lead pipe, conveying the mixture to farmyard-trough.

No. 5. Pump water-pipe flowing rapidly into No. 1, and disturbing the mixture.

No. 6. Water level in No. 1 trough.

It is important the troughs should be a good size—the larger the better—and fully three feet deep; but this must depend on the quantity of water required. The trough (No. 2) should be placed a few inches higher than No. 1, to prevent the person pumping from letting the mixture run over and causing waste. The pipe (No. 4) should not be less than 1½-inch bore, and protected from frost.

This plan of preparing soluble food for stock is attended with the additional labour only of putting the meal into No. 1. All the rest is self-acting, the water being set in motion by its own gravity. Some experience is necessary to determine the quantity of meal used: perhaps half-a-pound per head per day would be a fair allowance.

I am, Sir, your obedient servant,

J. J. Rowley.

Rowthorne, near Chesterfield, 24th Dec., 1860.

3.—*Letter from* C. Lawrence, Esq., *on the Use of the Reaping Machine, and the Root-Crops in* 1860.

Dear Sir,—In reply to your inquiry as to the result of my experience during this exceptional season in the use of reaping machines, and my crops of kohl-rabi and mangold, I have to observe first, as respects reaping machines, that I use that made by Burgess and Key. I reaped with this all my wheat, oats, and beans, and nearly all my barley. The land was for the most part in as unfavourable a state as it will ever be found during the season of harvest for the working of these machines, from the prevalence of rain antecedently. This involved an increase of power; and that difficulty was met by the employment of three powerful horses, the leader ridden by a boy, changed every three hours. At the turns the wheels sunk so deeply into the soft ground, that care and the occasional aid of a lever were required. The crops stood up fairly for such a season. They were successfully cut throughout without any material interruption, and without one shilling cost for any damage or repairs to the machine. Having seen in print, and heard accounts, of misadventures in the use of these machines during the present season, I think this testimony due to the manufacturers, the more particularly as it was the first season in which any of my people had handled a reaping machine.

With respect to kohl-rabi, I measured out a seed-bed, and sowed the quantity of seed on it directed in the paper of Messrs. Lawson, which appeared in the Society's Journal. I should recommend a seed-bed of double the area given, and the use of about half the allowance of seed, to be sown thinly in drills a foot apart. My plants so closely covered the ground that they were much drawn and weak; and though the seed was sown early in March, the plants were not fit to plant out till towards the end of May. About 15 per cent. threw out flowering stems; but as the land was kept filled up as any plants died, we have a fair crop of useful feed, on which we folded our lambs the beginning of November. The land planted is a light stone-brash lying over the oolite. The manuring consisted of 10 loads per acre of superior dung from the feeding-boxes, ploughed in in the autumn, bouted up in ridges before planting, and 2 cwt. of superphosphate, mixed with 30 bushels per acre of burned ashes and pig-dung, and their urine from the boarded pig-boxes in the previous autumn; in fact, the same manuring we give to mangold and swedes, &c. This mixture was inserted in the tops of the ridges by the ordinary manure-drill, after removing the seed-coulters before setting the plants.

My mangold was sown quite as early as usual, and under exactly the same circumstances, as respects manuring and other treatment, as in former years; and in three fields, each differing from the other more or less in the characters and natural fertility of soil; but the crop in each was at least 60 per cent. under our average produce. A dry, warm summer produces mangold of the heaviest weight and of the best quality. An excess over the average fall of

rain in the months of May, June, and July (exceeding 3 inches in the month of June), accompanied by a temperature upwards of 2° in May, 4° in June, and 6° in July, under the mean average of those months, will sufficiently account for the great falling off of this root in point of weight, and, it is to be feared, in point of feeding quality also.

Swedes are a more hardy plant, but they were seriously affected during the season of their usually rapid increase in size, and are an inferior crop everywhere within my observation. The most successful root-crops this season on my farm have been hybrids—the yellow Aberdeen and the Lincolnshire red turnips, sown towards the end of July after vetches, which had been fed off by sheep. The earliest sowing of these has produced as good turnips as I have grown in any season.

I am, dear Sir, yours truly,

CHARLES LAWRENCE.

The Quirns, Cirencester.

4.—*Extract from a Letter by* J. GURDON REBOW, Esq., *on the Feeding qualities of Half-bred Southdown and Leicester, as contrasted with the Pure Southdown Sheep.*

I WILL now give you the result of my sheep-grazing last winter. As you are aware, mine is a pure Southdown flock, crossed chiefly with Webb's, Lugar, and Overman's rams. Believing I could obtain a more valuable cross for grazing, I selected out of the 300 ewes the best 150, to breed Downs, and crossed the draught 150 with Leicester tups. From the produce of these two lots I kept 100 Downs, and 100 half-breds to put to roots; of the former 60 were ewe lambs to come into the flock. They were all born about the same time, that is, in January and February, 1859. I put each 100 in equal-sized folds (side by side) in a 30-acre field of swedes; their respective folds were advanced as required, and the difference was, that the half-breds finished their division in the morning, the Downs theirs in the evening of the *same day*, thus showing very satisfactorily that the former did not consume more than the latter. They afterwards fed together; and from the 23rd March, until sold, had corn (peas). The 200 consumed 16 combs (64 bushels) of peas. The half-bred Leicesters were sold on the 19th May at 46*s.*; those of the Downs not intended for the flock on the 2nd June, at 46*s.* 6*d.*; but as in the interim the price of meat had jumped up 1*d.* per lb., these selling-prices are no criterion. The buyer of the half-breds, however, valued the Downs on the 19th May at 5*s.* a-head less than those he purchased.

I weighed one of the best of each lot alive on four occasions; the following is the result:—

29 January, 1860.	lbs.
Half-bred Leicester	142
Down	136

1 March, 1860.		lbs.
Half-bred Leicester		148
Down		140
12 April, 1860.		
Half-bred Leicester weighed		158
Down		150
5, May, 1860, after shearing.		
Half-bred Leicester	152	
Wool	$8\frac{1}{2}$	
		160
Down	145	
Wool	7	
		152

so that I had for the half-breds—

	s.	d.
For the carcass an excess of	5	0
For $1\frac{1}{2}$lb. of wool sold at 1*s.* 10*d.* of ..	2	9
Or a total profit above the Downs of ..	7	9

I may add, that before going on to turnips, the whole 200 fed together in the park. I do not reckon for the future on grazing many pure Downs, and shall breed half-Leicesters from all my inferior ewes. This last season I crossed part of the draught ewes with a Cotswold ram, and am now grazing 75 half-Leicesters, 75 half-Cotswold, and 75 Down, three-fourths of the latter to come into the flock. I sold 100 of the worst lambs, consisting of about equal proportions of each variety, in August last at 26*s.*, and was then offered 30*s.* a-head for the half-breds that I reserved. You will perhaps be surprised at the small quantity of corn I give my sheep; the fact is, my farm has been overdone with sheep, and the corn almost invariably is lodged; hence I am growing fewer swedes and more mangold, and give the latter on the grass-land to the sheep."

Wivenhoe Park, Colchester, Dec. 1860.

5.—*The Root-Crops of* 1860. By P. H. Frere.

A season like that of 1860 gives unusual interest to any details of management connected with the root-crop. According to my experience, the kohl-rabi has best withstood both wet and frost, whether I look to an early sown piece, which has bulbs of between four and five pounds, with but little leaf, or to some strips sown in the middle of June, in alternation with white turnips for ewes and lambs, which present a mass of fresh green foliage with but little bulb.

The early crop was sown on the 7th of May with 8 tons of farm-yard manure, $2\frac{1}{2}$ cwt. of superphosphate, and 20 bushels of ashes, on rather a sandy loam worth 25*s.* per acre. The seed (Sutton's Green Variety) was drilled at the rate of not more than $1\frac{1}{2}$ lbs. per acre. The plant was very good and the crop regular, except where

it abutted on the corner of a plantation and was trimmed by wood-pigeons. A square chain gave a weight of 29 cwt. 43 lbs. (bulb and leaf), or about 14 tons 15 cwt. per acre. Ten good bulbs weighed 47 lbs. The bulbs are all sound (January 31st), except where they had been gnawed by game; they are a valuable vegetable for the table in this season of scarcity. I cannot think it desirable to incur the expense and delay of transplanting when $1\frac{1}{2}$ lbs. of seed will suffice. Those which I transplanted from a seed-bed did not attain to more than half the size of those drilled in the field. With regard to the crop sown late on similar land, similarly treated, but with rather less manure, I have not ascertained the weight per acre; but drilled at the width of 18 inches, and set out rather close, they present a mass of foliage such as is nowhere else to be seen; and as the white turnips have lost their top, they will be very valuable for the lambs. Drum-head cabbages, transplanted alongside of the early kohl-rabi, on land manured in the same way, gave 22 cwt. 36 lbs. on the square chain, or about 11 tons 3 cwt. per acre. These have not stood the weather as well as the kohl-rabi; those which had the best centres or balls have suffered most, and have rotted half through at least; those that ran to leaf are most serviceable. White turnips sown close by, with superphosphate and ashes only, gave 34 cwt. 14 lbs. (bulb and top) per square chain, or 17 tons 1 cwt. per acre, or, without the tops, 12 tons 5 cwt. Orange-globe mangold, grown with about 12 tons of manure and 2 cwt. of superphosphate, gave about 18 tons of roots this season on similar soil; about 25 tons being the standard crop.

Of swedes, those sown early on the ridge *were* the best; those sown late on the flat and earthed up by the last horsehoeing are *now* the most sound. I should estimate the former at 15 tons, the latter at 12 tons per acre. Those on the ridge were under orders for being pulled and set 8 rows in 2 rows, and earthed up in a furrow, when all autumn work being in arrear the frost took us by surprise. Had this work been done, it would, I think, have told well upon their keeping. Some of the largest bulbs are going from the root, perhaps from being in too immediate contact with manure; the frost too and the blast have caught the ridges; whereas the white turnip drills which took the line of the furrow have come out quite fresh and bright from their covering of snow. My stock of food is abundant for my diminishing flock; for my ewes, looking fully as well as usual, caught the blast at Christmas time. About 60 out of 280, chiefly shearlings, were struck with a chill; 50 have already dropped dead lambs, and of these 12 have died; but the mischief has nearly run its course.

END OF VOL. XXI.

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Royal Agricultural Society of England.

1861.

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Publisher—JOHN MURRAY, 50, Albemarle Street, W.
Bankers—Messrs. DRUMMOND, Charing Cross, S.W.

MEMORANDA.

ADDRESS OF LETTERS.—The Society's office being situated in the new postal district designated by the letter W, members, in their correspondence with the Secretary, are requested to subjoin that letter to the usual address.

GENERAL MEETING in London, May 22, 1861, at Twelve o'clock.

COUNTRY MEETING at Leeds commencing July 15th, 1861.

GENERAL MEETING in London, in December, 1861.

MONTHLY COUNCIL (for transaction of business), at 12 o'clock on the first Wednesday in every month, excepting January, September, and October: open only to Members of Council and Governors of the Society.

WEEKLY COUNCIL (for practical communications), at 12 o'clock on all Wednesdays in February, March, April, May, June, and July, excepting the first Wednesday in each of those months, and during adjournment: open to all Members of the Society, who are particularly invited by the Council to avail themselves of this privilege.

ADJOURNMENTS.—The Council adjourn over Easter, Passion, and Whitsun weeks, when those weeks do not include the first Wednesday of the month; from the first Wednesday in August to the first Wednesday in November; and from the first Wednesday in December to the first Wednesday in February.

DISEASES of Cattle, Sheep, and Pigs.—Members have the privilege of applying to the Veterinary Committee of the Society; and of sending animals to the Royal Veterinary College, on the same terms as if they were subscribers to the College.—(A statement of these privileges will be found in the present Appendix, p. lv.)

CHEMICAL ANALYSIS.—The privileges of Chemical Analysis enjoyed by Members of the Society will be found stated in the Appendix of the present volume, p. liv.

LOCAL CHEQUES.—Members are particularly requested not to forward Country Cheques for payment in London; but London Cheques, or Post-office Orders on Vere-street (payable to H. HALL DARE), in lieu of them. All Cheques are required to bear upon them a penny draft or receipt stamp, which must be cancelled in each case by the initials of the drawer. They may also conveniently transmit their Subscriptions to the Society, by requesting their Country Bankers to pay (through their London Agents) the amount at the Society's Office (No. 12, Hanover Square, London), between the hours of ten and four, when official receipts, signed by the Secretary, will be given for such payments.

NEW MEMBERS.—Every candidate for admission into the Society must be proposed by a Member; the proposer to specify in writing the full name, usual place of residence, and post-town, of the candidate, either at a Council meeting, or by letter addressed to the Secretary.

PACKETS BY POST.—Packets not exceeding two feet in length, width, or depth, consisting of written or printed matter (but not containing letters sealed or open), if sent without envelopes, or enclosed in envelopes open at each end, may be forwarded by the inland post, if stamped, at the following rates:—

For a packet not exceeding	4	ounces	(or quarter of a pound) . . .	1 penny.
" " "	8	"	(or half a pound)	2 pence.
" " "	16	"	(or one pound)	4 "
" " "	24	"	(or one pound and a half) . .	6 "
" " "	32	"	(or two pounds)	8 "

[And so on in the proportion of 8 ounces for each additional 2*d.*]

*** Members may obtain on application to the Secretary copies of an Abstract of the Charter and Bye-Laws, of a Statement of the General Objects, &c., of the Society, of Chemical and Veterinary Privileges, and of other printed papers connected with special departments of the Society's business.

Royal Agricultural Society of England.

GENERAL MEETING,

12, Hanover Square, Wednesday, December 12, 1861.

REPORT OF THE COUNCIL.

The Council have to report that the Society consists, at the present time, of—

85 Life Governors,
95 Annual Governors,
1,093 Life Members,
3,651 Annual Members, and
18 Honorary Members,

making a total of 4,942 names on the list.

The Members of the Society will have shared with the Council their sense of the great loss they have sustained by the decease of the Duke of Richmond, one of the Trustees of the Society, and will long cherish the memory of one who had filled three times the office of President, and always evinced a warm interest in the affairs of the Society.

The Council have elected the Duke of Marlborough to fill the vacancy among the Trustees, and Mr. Owen Wallis, of Overstone Grange, Northampton, to supply the vacancy among the general members of the Council, created by the resignation of Lord Southampton.

The statement of accounts for the half-year ending 30th June, 1860, has been approved by Messrs. Quilter, Ball, and Co., public accountants.

The funded capital consists of 12,000*l.* stock; and it is hoped

that a large portion of the arrears of subscription, amounting to 1,472*l.*, will be shortly paid up. It is found that many Members cease to pay their subscriptions under the impression that in this way they can terminate their membership; but the Council desire to remind them that by the bye-laws all Members are bound to pay their annual subscription until they shall withdraw from the Society by a notice in writing to the Secretary.

Every claim against the Society has been discharged, a complete system has been introduced into the accounts, and the Council feel confident in stating that the finances are in a favourable condition. It has been decided that a complete list of the Members shall be published in 1861.

Since the last General Meeting, Professor Voelcker has delivered a lecture on oilcake, pointing out the composition and feeding value of different descriptions, and the means usually adopted for adulteration.

The Country Meeting at Canterbury, though instructive in the varied character of the implements displayed and the nature of the live stock exhibited, did not prove successful in a financial point of view, and has entailed a considerable charge on the general funds of the Society.

The Council have to acknowledge the hospitable reception accorded to them at Canterbury by the Mayor, as well as the valuable and zealous assistance afforded by the Mayor and Corporation, and also by the Local Committee, in carrying out all necessary arrangements.

The Council have settled the live stock and implement prize-sheets for the Country Meeting, to be held next year at Leeds; and, in addition to the usual prizes, classes have been introduced for Sussex cattle and Cleveland horses. The trial of implements in 1861, according to the quadrennial system in force, will comprise drills, manure-distributors, horse-hoes, hay-machines, mowing-machines, reaping-machines, horse-rakes, carts, and waggons. Prizes, amounting to 200*l.*, will be offered for the best application of steam-power to the cultivation of the soil.

The Council have fixed that the Leeds Meeting shall take place in the week commencing Monday, July 15th. The Implement-Yard will be open on Monday morning, on the payment of 5*s.*; and the Cattle-Yard will be opened, without

any additional charge, as soon after one o'clock as the Judges have concluded their labours. On Tuesday and Wednesday both yards will be open at 2*s.* 6*d.*: on Thursday and Friday at 1*s.* This arrangement will afford the necessary facilities to all classes of that populous district.

The Society have, from time to time, been favoured, by order of the Secretary of State for Foreign Affairs, with copies of despatches received by Her Majesty's Government relating to the agriculture of Denmark, which will appear in the forthcoming number of the Journal, and with others drawing the attention of the Council to the cattle disease, and to a plan for economising seed-corn.

By Order of the Council,

H. Hall Dare,

Secretary.

Dr. HALF-YEARLY CASH ACCOUNT,

	£. s. d.	£. s. d.	£. s. d.
To Balance in hand, 1st January, 1860:—			
Bankers		1,339 8 0	
Secretary		3 4 4	
			1,342 12 4
To Income, viz.:—			
Dividend on Stock		146 17 6	
Subscriptions:—			
Governors' Annual	620 0 0		
Members' Annual	3,276 6 0		
Members' Life-Compositions ..	170 0 0		
		4,066 6 0	
Journal:—			
Sales	122 9 8		
Advertisements	39 10 9		
		162 0 5	
Country Meetings:—			
Chester	1 0 0		
Warwick	11 16 0		
Dividend from estate of late Secretary	970 11 10		
		983 7 10	
Sale of Sundries		46 4 0	
			5,404 15 9
To Canterbury Meeting, July, 1860:—			
Amount received on this account		.. ..	2,624 1 0
			£9,371 9 1

(Signed) A. N. HOOD, *for Finance Committee.*
QUILTER, BALL, JAY, & Co., *Accountants.*

BALANCE-SHEET,

LIABILITIES.

	£. s. d.	£. s. d.	£. s. d.
To Capital:—			
Surplus, 1st January, 1860		13,264 6 11	
Surplus of Income over the Expenditure during the Half-year, viz:—			
Income	5,404 15 9		
Expenditure	2,008 9 1		
		3,396 6 8	
			16,660 13 7
To Balance at Credit of Canterbury Exhibition, 1860		.. ..	796 2 10
			£17,456 16 5

FROM 1ST JANUARY TO 30TH JUNE, 1860. Cr.

	£.	s.	d.	£.	s.	d.	£.	s.	d.
By Expenditure:—									
Establishment, including Rent, Taxes, and Salaries				583	0	5			
Postage and Carriage				30	5	2			
Journal:—									
Printing	415	10	6						
Literature	181	0	6						
Stitching	60	6	2						
Delivery, Advertising, &c.	141	12	11						
				798	10	1			
Chemical Grant				325	0	0			
Veterinary Grant				200	0	0			
Advertisements				7	19	0			
Warwick Meeting Arrears				40	0	0			
Testimonial to B. T. Brandreth Gibbs, Esq., Honorary Secretary				19	0	6			
Sundries				3	13	11			
Subscription returned				1	0	0			
							2,008	9	1
By Investment:—									
2000*l.* New 3 per cents.				..	..		1,875	0	0
By Country Meetings:—									
Paid on account—									
Canterbury, 1860				1,827	16	2			
Leeds, 1861				0	2	0			
							1,827	8	2
By Balance in hand:—									
Bankers				3,647	6	10			
Secretary				12	15	0			
							3,660	1	10
							£9,371	9	1

Examined, audited, and found correct, this 7th day of December, 1860.

(Signed) WILLIAM ASTBURY, HENRY CORBET, } *Auditors on the part of the Society.*

30TH JUNE, 1860.

ASSETS.	£.	s.	d.	£.	s.	d.
By Cash in hand	..	..		3,660	1	10
By New 3 per cent. Stock 12,000*l.*, cost.	..	..		11,796	14	7
By Books and Furniture, Society's House, Hanover Square	..	..		2,000	0	0
Mem.—The above Assets are exclusive of the amount recoverable in respect of Subscriptions in arrear 30th June, 1860, which at that date amounted to 3,697*l.*						
				£17,456	16	5

COUNTRY-MEETING ACCOUNT: CANTERBURY, 1860.

Receipts.

	£.	s.	d.
Subscription from Canterbury	1500	0	0
Admissions to the Show Yard	2739	6	10
Sale of Catalogues	279	12	0
Sale of Council Badges	4	2	6
Repayment for Lodgings not occupied	1	0	0
Implement Exhibitors' payment for shedding	718	19	0
Non-Members' Fees for entry of Implements	43	0	0
Fees for entry of Live-Stock	327	0	0
" " " Hops and Wool	6	10	0
*Fines for non-Exhibition of Live-Stock	21	10	0
*Extra lines in Implement Catalogues	10	17	0
Sale of Wheat, Barley, Oats, Straw, &c.	228	0	6
Excess of Payments over Receipts, chargeable to the General Funds of the Society	2005	9	8
	£7884	19	6

(Signed) A. N. HOOD,
Chairman of Finance Committee.

Expenditure.

	£.	s.	d.
Show and Trial Yards, hire of Hurdles and Turnstiles	2828	4	5
Hire of Steam-Engines	8	0	0
Judges of Implements, 206*l.*; Stock, 280*l.*; Hops and Wool, 32*l.*	518	0	0
†Consulting-Engineer and Assistants, including carriage of Dynamometers, &c.	119	15	1
Veterinary-Inspectors and Assistants	54	0	0
Lodgings for Stewards and Judges	197	13	0
Refreshments for ditto	68	10	0
Yardmen, Watchmen, and Labourers	147	15	6
Catalogues, Implements, 276*l.* 2*s.* 6*d.*; Stock, 96*l.* 15*s.*; Sellers of, 22*l.* 1*s.*; Packing-cases and carriage, 7*l.* 19*s.*	402	17	6
Index-Clerk, Door-keeper, Money-takers, Assistant Steward, &c.	143	18	0
Director's Clerk, Bankers' Clerks, &c.	87	14	2
Wheat, 300*l.*; Insurance of, 4*l.* 14*s.* 10*d.*; Barley, 91*l.* 5*s.* 8*d.*; Hay and Straw, 89*l.* 16*s.* 10*d.*; Tares, 56*l.* 17*s.* 6*d.*; Oats, Cake, Coals, Twine, &c. 62*l.* 5*s.* 10*d.*	605	0	8
Surveying Ground and Crops for ploughing and reaping	21	0	0
Hire of Horses	149	5	0
Metropolitan Police	113	4	0
Stationery and Postage: Director, 18*l.* 13*s.* 5*d.*; Secretary, 13*l.* 16*s.* 2*d.*	32	9	7
Badges for Members of Council, Stewards, Judges, &c.	10	12	9
Prize-sheets, Programmes, Certificates, Labels, &c.	163	16	0
Advertisements	195	7	8
Award Lists	41	10	6
Hire of Glass-cases, Oil, Resin, &c.	5	16	0
Fees returned	1	15	0
Dinner-tickets to guests, Bills of Fare, &c.	14	8	0
Petty payments:—Director, 2*l.* 17*s.* 11*d.*; Secretary, 1*l.* 2*s.*	3	19	11
Official Staff, Board and Travelling expenses	8	9	9
Implement Prizes awarded and paid, 293*l.*; Live-Stock, 1645*l.*; Medals, 3*l.* 17*s.*	1941	17	0
	£7884	19	6

* Fines remaining unpaid:—Live-Stock, 7*l.* 10*s.*; Implements, 3*l.* 12*s.*
† The amount expended in the purchase of a new Dynamometer is not charged to this account.

Essays and Reports.—PRIZES FOR 1861.—All Prizes of the Royal Agricultural Society of England are open to general competition. Competitors will be expected to consider and discuss the heads enumerated.

I. FARMING OF YORKSHIRE.

A Special Prize of FIFTY SOVEREIGNS, offered by the President, the Earl of Powis, will be given for the best Report on the Improvement in the Farming of Yorkshire since the date of the last Reports in the Journal.

II. AGRICULTURE OF HAMPSHIRE.

FIFTY SOVEREIGNS will be given for the best Report on the Agriculture of Hampshire.

The principal geological and physical features of the county should be described; the nature of the Soil and character of the Farming in its different districts or natural divisions; its Live Stock; Implements; recent changes of Farm Management; Improvements lately introduced or still required; remarkable or characteristic Farms; the History of the New Forest should be briefly traced, and any peculiar customs connected with it described.

III. DRAINAGE.

TEN SOVEREIGNS will be given for the best Essay on the Results of Drainage at different depths on different soils as tested by the wet season of 1860, including the effect of laying down drained land flat, instead of following the direction of the ridges.

The influence of subsoiling, as subsidiary to draining, should be taken into account. The effect of variations in the drainage on the crops should be tested by ascertaining, not estimating, the yield of the several lands. A practical rule should, if possible, be deduced, which will follow the broad geological distinctions between strata, or some other definite law.

IV. THE WINTERING OF DAIRY STOCK.

TEN SOVEREIGNS will be given for the best Essay on the best mode of Wintering Dairy Stock.

V. CROSS BREEDING OF CATTLE.

TEN SOVEREIGNS will be given for the best Essay on the general principles and results involved in the Cross Breeding of Cattle.

An account should be given of the difference produced in the offspring according as the male or female parent is of a given race, of the milking as well as fattening qualities of the half-bred stock, and of the effects produced by a second cross with the original stock, or by putting half-bred animals together.

VI.

TEN SOVEREIGNS will be given for the best Essay on the Rearing of Calves.

The advantages or drawbacks attendant on allowing the calf to suck the cow should be discussed, the extent to which new milk should be given to weaning calves, and the best artificial substitutes for the fatty matter contained in the cream, considered; the diseases to which calves are liable should be described, and the best preventatives in respect of diet and management, together with some simple remedies suggested.

VII. HARVESTING CORN.

TEN SOVEREIGNS will be given for the best Essay on the best mode of Harvesting and Thrashing Corn.

The comparative advantages of mowing, "bagging," and reaping wheat should be considered, in respect of labour of men and horses, in cutting, carting, stacking, and thrashing; of variations of climate; of the value of the straw; and of preparation for autumn cultivation; the best position for the stacks should be pointed out, and the comparative advantage of thrashing in the field or in the barn; the benefit derived from large barns should be reviewed in relation to their cost, and the possibility of providing a less costly substitute considered.

VIII.

TEN SOVEREIGNS will be given for the best Essay on any other Agricultural Subject.

Reports or Essays competing for the Prizes must be sent to the Secretary of the Society, at 12, *Hanover Square, London, on or before March* 1, 1861. *Contributors of Papers are requested to retain Copies of their Communications, as the Society cannot be responsible for their return.*

RULES OF COMPETITION FOR PRIZE ESSAYS.

1. All information contained in Prize Essays shall be founded on experience or observation, and not on simple reference to books or other sources. Competitors are requested to use foolscap or large letter paper, and not to write on both sides of the leaf.

2. Drawings, specimens, or models, drawn or constructed to a stated scale, shall accompany writings requiring them.

3. All competitors shall enclose their names and addresses in a sealed cover, on which only their motto, the subject of their Essay, and the number of that subject in the Prize List of the Society, shall be written.*

4. The President or Chairman of the Council for the time being shall open the cover on which the motto designating the Essay to which the Prize has been awarded is written, and shall declare the name of the author.

5. The Chairman of the Journal Committee shall alone be empowered to open the motto-paper of any Essay not obtaining the Prize, that he may think likely to be useful for the Society's objects; with a view of consulting the writer confidentially as to his willingness to place such Essay at the disposal of the Journal Committee.

6. The copyright of all Essays gaining Prizes shall belong to the Society, who shall accordingly have the power to publish the whole or any part of such Essays; and the other Essays will be returned on the application of the writers; but the Society do not make themselves responsible for their loss.

7. The Society are not bound to award a prize unless they consider one of the Essays deserving of it.

8. In all reports of experiments the expenses shall be accurately detailed.

9. The imperial weights and measures only are those by which calculations are to be made.

10. No prize shall be given for any Essay which has been already in print.

11. Prizes may be taken in money or plate, at the option of the successful candidate.

12. All Essays must be addressed to the Secretary, at the house of the Society.

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* Competitors are requested to write their motto on the enclosed paper on which their names are written, as well as on the outside of the envelope.

Leeds Meeting, 1861:

IN THE WEEK COMMENCING MONDAY, THE 15TH OF JULY.

SCHEDULES OF PRIZES.

I.—Live-Stock Prizes offered by the Society.

CATTLE.

	First Prize.	Second Prize.	Third Prize.
	£.	£.	£.
SHORT-HORNED CATTLE.			
For Bulls calved on or before the 1st of July, 1859, and not exceeding six years old	30	15	5
For Bulls calved since the 1st of July, 1859, and more than one year old	25	15	5
For Bull-Calves above six and not exceeding twelve months old	10	5	..
For Cows in-milk or in-calf above three years old ..	20	10	5
For Heifers in-milk or in-calf not exceeding three years old	15	10	5
For Yearling Heifers	15	10	5
For Heifer-Calves above six and under twelve months old	10	5	..
HEREFORD CATTLE.			
For Bulls calved on or before the 1st of July, 1859, and not exceeding six years old	30	15	5
For Bulls calved since the 1st of July, 1859, and more than one year old	25	15	5
For Bull-Calves above six and not exceeding twelve months old	10	5	..
For Cows in-milk or in-calf above three years old ..	20	10	5
For Heifers in-milk or in-calf not exceeding three years old	15	10	5
For Yearling Heifers	15	10	5
For Heifer-Calves above six and under twelve months old	10	5	..
DEVON CATTLE.			
For Bulls calved on or before the 1st of July, 1859, and not exceeding six years old	30	15	5
For Bulls calved since the 1st of July, 1859, and more than one year old	25	15	5
For Bull-Calves above six and not exceeding twelve months old	10	5	..
For Cows in-milk or in-calf above three years old ..	20	10	5
For Heifers in-milk or in-calf not exceeding three years old	15	10	5
For Yearling Heifers	15	10	5
For Heifer-Calves above six and under twelve months old	10	5	..

	First Prize.	Second Prize.	Third Prize.
	£.	£.	£.
SUSSEX CATTLE.			
For the best Bull calved on or before the 1st of July, 1859, and not exceeding six years old	10	..	..
For the best Bull calved since the 1st of July, 1859, and more than one year old	10	..	..
For the best Cow in-milk or in-calf above three years old	10	..	..
For the best Heifer in-milk or in-calf not exceeding three years old	10	..	..
For the best Yearling Heifer	5	..	..
OTHER ESTABLISHED BREEDS. (*Not including the Short-Horn, Hereford, Devon, or Sussex Breeds.*)			
For the best Bull calved on or before the 1st of July, 1859, and not exceeding six years old	10	..	..
For the best Bull calved since the 1st of July, 1859, and more than one year old	10	..	..
For the best Cow in-milk or in-calf above three years old	10	..	..
For the best Heifer in-milk or in-calf not exceeding three years old	10	..	..
For the best Yearling Heifer	5	..	..

HORSES.

For the Thorough-Bred Stud-Horse, having served Mares during the season 1861, which, in the opinion of the Judges, is best calculated to improve and perpetuate the breed of the sound and stout Thorough-Bred Horse for General Stud Purposes ..	100	25	..
AGRICULTURAL HORSES GENERALLY.			
For Stallions for Agricultural Purposes, foaled on or before the 1st of January, 1859	25	15	5
For Stallions for Agricultural Purposes, foaled in the year 1859	20	10	5
For Mares and Foals for Agricultural Purposes ..	20	10	5
For Two-years old Fillies for Agricultural Purposes	15	10	5
DRAY HORSES.			
For Stallions foaled on or before the 1st of January, 1859	25	10	5
For Stallions foaled in the year 1859	15	10	5
For Mares with their foals at their feet	20	10	5
For Fillies foaled in the year 1859	15	10	5

	First Prize.	Second Prize.	Third Prize.
	£.	£.	£.
CLEVELANDS.			
For the best Stallion of any age	20	..	..
For the best Mare three years old and upwards ..	10	..	..
For the best Filly two years old	5	..	..
OTHER HORSES.			
For Stallions suitable for getting hunters	25	15	5
For Brood Mares, with foal at foot, or in-foal, for breeding hunters	15	10	5
For Brood Mares, with foal at foot, or in-foal, for breeding hackneys	15	10	5

SHEEP.

	First Prize.	Second Prize.	Third Prize.
LEICESTERS.			
For Shearling Rams	20	10	5
For Rams of any other age	20	10	5
For a Pen of five Shearling Ewes of the same flock ..	20	10	5
SOUTH-DOWNS.			
For Shearling Rams	20	10	5
For Rams of any other age	20	10	5
For a Pen of five Shearling Ewes of the same flock ..	20	10	5
SHROPSHIRES.			
For Shearling Rams	15	10	5
For Rams of any other age	15	10	5
For a Pen of five Shearling Ewes of the same flock ..	15	10	5
LONG-WOOLLED SHEEP. *(Not qualified to compete as Leicesters.)*			
For Shearling Rams	20	10	5
For Rams of any other age	20	10	5
For a Pen of five Shearling Ewes of the same flock ..	20	10	5
SHORT-WOOLLED SHEEP. *(Not qualified to compete as South-Downs or Shropshire Sheep.)*			
For Shearling Rams	20	10	5
For Rams of any other age	20	10	5
For a Pen of five Shearling Ewes of the same flock ..	20	10	5

PIGS.

	First Prize.	Second Prize.	Third Prize.
	£.	£.	£.
For Boars of a large breed, of any colour	10	5	..
For Boars of a small white breed	10	5	..
For Boars of a small black breed	10	5	..
For Boars of a breed not eligible for the preceding classes	10	5	..
For Breeding Sows of a large breed, of any colour ..	10	5	..
For Breeding Sows of a small white breed	10	5	..
For Breeding Sows of a small black breed	10	5	..
For Breeding Sows of a breed not eligible for the preceding classes	10	5	..
For a Pen of three Breeding Sow-Pigs of a large breed, of any colour, of the same litter, above four and under eight months old	10	5	..
For a Pen of three Breeding Sow-Pigs of a small white breed, of the same litter, above four and under eight months old	10	5	..
For a Pen of three Breeding Sow-Pigs of a small black breed, of the same litter, above four and under eight months old	10	5	..
For a Pen of three Breeding Sow-Pigs of a breed not eligible for the preceding classes, of the same litter, above four and under eight months old	10	5	..

II.—Implement and Machinery Prizes offered by the Society.

Steam Cultivators.	£.
The best application of Steam Power to the cultivation of the soil ..	100
Ditto ditto ditto worked by an ordinary Portable Engine not exceeding 10 horse-power	100

Drills.	
Corn and General Purpose Drills	30
Ditto ditto for small occupations	10
Turnips and other roots	30
Water Drills	10
Drills for small seeds	10
Drill-Pressers	10

Manure Distributors.	
Distributors for dry manure	10
Ditto for liquid manure	10

Horse-Hoes.	£.
Horse-Hoes for general purposes	15
Single-row Horse-Hoes for ridge and flat	10
Horse-Hoes for thinning turnips	5
Mowing Machines.	
For natural and artificial grasses	20
Hay-making Machines	10
Reaping Machines.	
For cutting, with self-delivery	20
For cutting the corn, without self-delivery	10
For combined reaping and grass-mowing	20
Horse-Rakes	10
Waggons.	
Pair-horse Waggons	10
Other Waggons	10
Carts.	
Single-horse Carts	10
Two-horse Carts	10
Harvest Carts	5
Market Carts on springs	5
Miscellaneous.	
Awards to Agricultural articles and essential improvements therein (10 medals)	20

III.—Special Prizes offered by the Leeds Local Committee.

LABOURERS.

A sum not exceeding 100*l.* to be at the disposal of the Local Committee, and distributed by them amongst the Servants who may be in charge of the first-prize animals or implements, subject to such limits of service, or otherwise, as they may deem fit. Medals if preferred .. £100

HORSES.

	First Prize.	Second Prize.
	£.	£.
For Blood Hunters, Mares or Geldings, five years old (2 crosses)	20	10
Ditto ditto four years old ditto	15	5
For Hunting Mares or Geldings three years old	5	..
For Coaching Stallions	10	5
For Coaching Mares three years old	5	..
For Coaching Brood-Mares, with a foal, or stinted	5	..
For Roadster Stallions	10	5
For Roadster Mares or Geldings, any age, under 15½ hands ..	10	..
For a pair of Dray Horses, Mares or Geldings, or Mare and Gelding	10	..
For a pair of Mares or Geldings, or Mare and Gelding, for Agricultural purposes	10	5
For Geldings three years old, for Agricultural purposes ..	5	..
For Mares three years old ditto ditto ..	5	..
For Gelding Ponies under 14 hands	5	..
For Mare Ponies ditto	5	..
For Mare or Gelding Ponies under 12 hands	5	..

CATTLE.

For Cows for Dairy purposes, in-calf or in-milk	10	5

SHEEP.

LONG-WOOLLED SHEEP.

(*Neither Leicesters nor Cotswolds.*)

	£.
For the best Shearling Ram	10
For the best Ram of any age	10
For the best pen of five Ewes of the same flock	10

MOUNTAIN SHEEP.

For the best Shearling Cheviot Ram	5
For the best pen of five Cheviot Ewes of the same flock	5
For the best Black-faced Ram of any age	5
For the best pen of five Black-faced Ewes of the same flock	5
For the best Lonk Ram with dark or mottled face	5
For the best pen of five Lonk Ewes with dark or mottled faces, of the same flock	5

PRIZES OFFERED BY LORD LONDESBOROUGH.

For the best Hunting Colt three years old	20
For the best pen of five Leicester Ewes, of the same flock, not being shearlings	10

CHEESE.

	First Prize.	Second Prize.	Third Prize.
	£.	£.	£.
For the best Cheese, one or more, not less than 28 lbs. weight, nor less than six months old	5	3	..
For the best six Cream Cheeses	3	..	..

BUTTER.

For the best, one or more, Rolls or Pats of Butter, not less than 20 lbs.	5	..	..
For the best, one or more, Rolls or Pats of Butter, not less than 5 lbs.	3	..	..

WOOL.

LONG-WOOLLED SHEEP.

For six Fleeces, deep staple and bright fibre, for Hogs, not exceeding 9 lbs.	10	5	..
For six Fleeces, deep staple and bright fibre, for Ewes, not exceeding 6 lbs.	10	5	..
For six Fleeces, deep staple and bright fibre, for Hogs, 9 lbs. or upwards	10	5	..
For six Fleeces, deep staple and bright fibre, for Ewes, 6 lbs. or upwards	10	5	..
For six Fleeces, deep staple, and *not* bright fibre, for Hogs, any weight	10	5	..
For six Fleeces, deep staple, and *not* bright fibre, for Ewes, any weight	10	5	..

SHORT-WOOLLED SHEEP.

For six Hog-Fleeces	10	5	..
For six Ewe-Fleeces	10	5	..

FLAX.

For Green Flax, English grown, and exhibited by the grower only, pulled from fields of 5 acres and up to 10 acres	9	6	3
For Green Flax, English grown, and exhibited by the grower only, pulled from fields of 10 acres and up to 20 acres	12	8	4
For Green Flax, English grown, and exhibited by the grower only, pulled from fields of 20 acres and upwards	15	10	5
For Prepared Flax, to be exhibited by the preparer only, retted, scutched, and handled mill-scutched Flax ..	20	10	5
Retted, scutched, and handled hand-scutched Flax ..	20	10	5
[No sample to be of less weight than five hundredweight, and all scutched flax to be retted, scutched, and handled in 1861.]			

ESSAY.

	£.
Essay on the Best Mode of Getting in the Harvest in a Bad Season ..	10

BUILDING DESIGNS.

For the best pair of Agricultural Cottages, containing not less than three bed-rooms in each, and with suitable conveniences attached, already built, or to be built by the 1st of June, 1861, within ten miles of the Leeds Town Hall, at a cost not exceeding £180	20
For the best single ditto, at a cost not exceeding £110	10

[The Local Committee also intend to build, on a piece of land near to the Show-Yard, the pair of Agricultural Cottages to which the first prize offered by the Yorkshire Society may be awarded, provided they approve of the design; and if they do not, they will then adopt some other design.]

For the best Design for Covering a quantity of Land with Dwellings, in blocks suitable for working men in towns, at rentals varying from £6 to £10 per annum, and at a cost which will allow of a return of not less than £7½ per cent. per annum upon the building outlay (exclusive of the cost of the land)	50

[N.B.—Especial attention will be paid to the modes of ventilation provided in the case of back-to-back cottages, and to the sanitary arrangements throughout. Particulars and conditions of competition may be had from the Honorary Secretaries of the Local Committee at Leeds.]

CONDITIONS RELATING TO LIVE-STOCK PRIZES.

1. No bull in Class I. of any of the divisions of cattle will be eligible for a prize unless a certificate is produced of his having served not less than three different cows (or heifers) within the three months preceding the 1st of June in the year of the Show.

2. No cow in-milk (and not in-calf) will be eligible for a prize unless certified to have had a live calf, either between the date of entry and that of the Show, or within the twelve months preceding the date of the Show.

3. No cow entered as in-calf (and not in-milk) will be entitled to a prize until certified to have produced a live calf in due course subsequently to the Show.

4. No cow entered as both in-calf and in-milk will be eligible for a prize unless certified to have produced a live calf between the date of entry and that of the Show, or within the twelve months preceding the date of the Show, or in due course subsequently to the Show.

5. No heifer entered as in-calf will be eligible for a prize unless she is certified to have been bulled before the 31st of March in the year of Show, nor

will her owner afterwards receive the prize until he shall have furnished the Secretary with a further certificate that she produced a live calf before the 31st of January in the subsequent year.

6. All foals must be the offsprings of the mare along with which they are exhibited for the prize.

7. The ewes in each pen must be of the same flock.

8. The three sow-pigs in each pen must be of the same litter.

9. The Judges of pigs will be instructed, with the sanction of the stewards, to withhold prizes from any animals which shall appear to them to have been entered in a wrong class, and to affix a placard of disqualification to the pens of those animals.

10. All pigs exhibited at the country meetings of the Society shall be subjected to an examination of their mouths by the veterinary inspector of the Society; and should the state of dentition in any pig indicate that the age of the animal has not been correctly returned in the certificate of entry, the stewards shall have power to disqualify such pig, and shall report the circumstance to the Council at its ensuing monthly meeting.

11. No horse shall be exhibited without a certificate from a Member of the Royal College of Veterinary Surgeons as to the state of the animal with reference to hereditary diseases, particularly those of the respiratory organs, which certificate shall accompany the Certificate of Entry; but the above shall not supersede the usual examination by the Society's Veterinary Inspector.

RULES OF ADJUDICATION.

1. As the object of the Society in giving prizes for neat cattle, sheep, and pigs, is to promote improvement in *breeding* stock, the Judges in making their awards will be instructed not to take into their consideration the present value to the butcher of animals exhibited, but to decide according to their relative merits for the purpose of breeding.

2. If, in the opinion of the Judges, there should be equality of merit, they will be instructed to make a special report to the Council, who will decide on the award.

3. The Judges will be instructed to withhold any prize if they are of opinion that there is not sufficient merit in any of the stock exhibited for such prize to justify an award; should, however, the question of disqualifying a whole class arise, the Judges shall consult with the stewards of the yard, and their joint decision shall be final.

4. The Judges will be instructed to give in a "reserved number" in each class of live stock, viz., which animal would in their opinion possess sufficient merit for the prize in case the animal to which the prize is awarded should subsequently become disqualified.

5. In the classes for stallions, mares, and fillies, the Judges in awarding the prizes will be instructed, in addition to symmetry, to take activity and strength into their consideration.

6. The Judges will be instructed to deliver to the Director their award, signed, and stating the numbers to which the prizes are adjudged, before they leave the yard.

CONDITIONS RELATING TO MACHINERY.

Steam-engines.

All engines must be fitted with a steam-indicator, in addition to the ordinary spring-balance. The actual power used during the respective trials will be correctly ascertained.

Drills.

The General-Purpose Drills, both for large and small occupations, must be adapted for all kinds of corn and seeds, manures dry and moist, in quantities varying from 3 to 40 bushels per acre, and to have either fore or hind steerage.

The Small Occupation Seed and Manure Drill will not compete with the drill of a higher price, as its price to the purchaser will be a material consideration.

The Turnip Drills must be adapted for the ridge and flat, and for manures both dry and moist, in quantities varying from 3 to 40 bushels per acre.

Horse-Hoes.

The Horse-Hoes in Class 3 should be adapted to set out turnips at various widths, and leave the plants in such a state that they can ultimately be singled by hand.

Horse-Hoes should be adapted to ridge and flat work, and to work in widths from 8 to 27 inches.

The Manure Distributor will be preferred which is best adapted for distributing any kind of artificial manure when in a moist or dry state, and which is capable of adjustment for the delivery of any quantity from 3 to 40 bushels per acre.

*** Forms of Certificate for entry, as well as Prize-Sheets for the Leeds Meeting, containing the whole of the conditions and regulations, may be obtained at the Office of the Society, No. 12, Hanover Square, London.

DATES OF ENTRY.

Certificates for the entry of Implements, Cheese, Butter, Wool, and Flax, for the Leeds Meeting must be forwarded to the Secretary of the Society, No. 12, Hanover Square, London (W.), by the 1st of May, and Certificates for the entry of Live Stock by the 1st of June. Certificates received after those respective dates will not be accepted, but returned to the persons by whom they have been sent.

The Prizes of the Royal Agricultural Society of England are open to general competition.

Members' Privileges of Chemical Analysis.

The Council have fixed the following rates of Charge for Analyses to be made by the Consulting Chemist for the *bonâ-fide* use of Members of the Society; who (to avoid all unnecessary correspondence) are particularly requested, when applying to him, to mention the kind of analysis they require, and to quote its number in the subjoined schedule. The charge for analysis, together with the carriage of the specimens, must be paid to him by members at the time of their application.

No. 1.—An opinion of the genuineness of Peruvian guano, bone-dust, or oil-cake (each sample)	5s.
,, 2.—An analysis of guano; showing the proportion of moisture, organic matter, sand, phosphate of lime, alkaline salts, and ammonia	10s.
,, 3.—An estimate of the value (relatively to the average of samples in the market) of sulphate and muriate of ammonia, and of the nitrates of potash and soda	10s.
,, 4.—An analysis of superphosphate of lime for soluble phosphates only	10s.
,, 5.—An analysis of superphosphate of lime, showing the proportions of moisture, organic matter, sand, soluble and insoluble phosphates, sulphate of lime, and ammonia ..	£1.
,, 6.—An analysis (sufficient for the determination of its agricultural value) of any ordinary artificial manure	£1.
,, 7.—Limestone:—the proportion of lime, 7*s.* 6*d.*; the proportion of magnesia, 10*s.*; the proportion of lime and magnesia	15s.
,, 8.—Limestone or marls, including carbonate, phosphate, and sulphate of lime, and magnesia with sand and clay ..	£1.
,, 9.—Partial analysis of a soil, including determinations of clay, sand, organic matter, and carbonate of lime	£1.
,, 10.—Complete analysis of a soil	£3.
,, 11.—An analysis of oil-cake, or other substance used for feeding purposes; showing the proportion of moisture, oil, mineral matter, albuminous matter, and woody fibre; as well as of starch, gum, and sugar, in the aggregate	£1.
,, 12.—Analyses of any vegetable product	£1.
,, 13.—Analyses of animal products, refuse substances used for manure, &c.	from 10s. to 30s.
,, 14.—Determination of the "hardness" of a sample of water before and after boiling	10s.
,, 15.—Analysis of water of land drainage, and of water used for irrigation	£2.
,, 16.—Determination of nitric acid in a sample of water	£1.

N.B.—*The above Scale of Charges is not applicable to the case of persons commercially engaged in the Manufacture or Sale of any Substance sent for Analysis.*

The Address of the Consulting Chemist of the Society is, Dr. Augustus Voelcker, Cirencester, Gloucestershire, to which he requests that all letters and parcels (postage and carriage paid) should be directed: for the convenience, however, of persons residing in London, parcels sent to the Society's Office, No. 12, Hanover Square, W., will be forwarded to Cirencester once or twice a week.

Members' Veterinary Privileges.

I.—Veterinary Inspection.

No. 1. Any member of the Society who may desire a competent professional opinion and special advice in cases of extensive or destructive disease among his stock, and will address a letter to the Secretary, will, by return of post, receive a printed list of queries, to be filled up and returned to him immediately. On the receipt of such returned list, the Secretary will convene the Veterinary Committee forthwith (any two Members of which, with the assistance of the Secretary, will be competent to act); and such Committee will decide on the necessity of despatching Professor Simonds, the Society's Veterinary Inspector, to the spot where disease is said to prevail.

No. 2. The remuneration of such Inspector will be 2*l.* 2*s.* each day as a professional fee, and 1*l.* 1*s.* each day on account of personal expenses; and he will also be allowed to charge the cost of travelling to and from the localities where his services may have been thus required. The fees will be paid by the Society, but the travelling expenses will be a charge against the applicant for professional aid. This charge may, however, be reduced or remitted altogether at the discretion of the Council, on such step being recommended to them under peculiar circumstances by the Veterinary Committee.

No. 3. The Inspector, on his return from visiting the diseased stock, shall report to the Committee, in writing, the results of his observations and proceedings, which report will be laid before the Council.

No. 4. Should contingencies arise to prevent a personal discharge of the duties confided to the Inspector, he may, subject to the approval of the Committee, name some competent professional person to act in his stead, who shall receive the same rates of remuneration.

II.—Investigations, Lectures, and Reports.

No. 1. All Members of the Society have the privilege of sending cattle, sheep, and pigs to the Royal Veterinary College, on the same terms as if they were Members of the College.

No. 2. The College have undertaken to investigate such particular classes of disease, or special subjects connected with the application of the Veterinary art to cattle, sheep, and pigs, as may from time to time be directed by the Council.

No. 3. In addition to the increased number of lectures now given by Professor Simonds, the Lecturer on Cattle Pathology, to the Pupils in the Royal Veterinary College, he will also deliver such lectures before the Members of the Society, at their house in Hanover Square, or at its Annual Meetings in the country, as the Council may decide.

No. 4. The Royal Veterinary College will from time to time furnish to the Council of the Society a detailed Report of the cases of cattle, sheep, and pigs treated in the College.

Royal Agricultural Society of England.

1860—1861.

President.

THE EARL OF POWIS.

Trustees.

Acland, Sir Thomas Dyke, Bart.
Berners, Lord
Bramston, Thomas William, M.P.
Challoner, Colonel
Graham, Rt. Hon. Sir Jas., Bart., M.P.
Portman, Lord
Richmond, Duke of
Rutland, Duke of
Shelley, Sir John Villiers, Bart., M.P.
Speaker, The Rt. Hon. The
Sutherland, Duke of
Thompson, Harry Stephen, M.P.

Vice-Presidents.

Ashburton, Lord
Barker, Thomas Raymond
Chichester, Earl of
Downshire, Marquis of
Egmont, Earl of
Eversley, Viscount
Exeter, Marquis of
Hardwicke, Earl of
Hill, Viscount
Johnstone, Sir John V. B., Bart., M.P.
Miles, Sir William, Bart., M.P.
Yarborough, Earl of

Other Members of Council.

Acland, Thomas Dyke
Amos, Charles Edwards
Barnett, Charles
Barrow, William Hodgson, M.P.
Barthropp, Nathaniel George
Brandreth, Humphrey
Buller, James Wentworth, M.P.
Caldwell, Henry Berney
Cavendish, Hon. William George, M.P.
Druce, Joseph
Exall, William
Feversham, Lord
Gibbs, B. T. Brandreth
Hamond, Anthony
Hobbs, William Fisher
Hood, Colonel The Hon. A. Nelson
Hoskyns, Chandos Wren
Howard, James
Hudson, John
Humberston, Philip Stapylton, M.P.
Hutton, William
Jonas, Samuel
Kerrison, Sir Edward Clarence, Bt., M.P.
Kinder, John
Lawes, John Bennet
Lawrence, Charles
Leigh, Lord
Macclesfield, Earl of
Marlborough, Duke of
Milward, Richard
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Pennant, Col. the Hon. Douglas, M.P.
Pope, Edward
Powis, Earl of
Shuttleworth, Joseph
Slaney, Robert Aglionby, M.P.
Smith, Robert
Stanhope, James Banks, M.P.
Torr, William
Towneley, Lieut.-Colonel Charles
Tredegar, Lord
Turner, George
Vernon, Hon. Augustus
Walsingham, Lord
Webb, Jonas
Western, Thomas Burch
Wilson, Henry
Wilson, Professor
Wynn, Sir Watkin Williams, Bart., M.P.

Secretary.

H. HALL DARE, 12, *Hanover Square, London,* **W.**

Consulting-Chemist—Dr. AUGUSTUS VOELCKER, Royal Agricultural College, Cirencester.
Veterinary-Inspector—JAMES BEART SIMONDS, Royal Veterinary College, **N.W.**
Consulting Engineer—JAMES EASTON, or C. E. AMOS, The Grove, Southwark, **S.E.**
Seedsmen—THOMAS GIBBS and Co., Corner of Halfmoon Street, Piccadilly, **W.**
Publisher—JOHN MURRAY, 50, Albemarle Street, **W.**
Bankers—Messrs. DRUMMOND, Charing Cross, **S.W.**

MEMORANDA.

ADDRESS OF LETTERS.—The Society's office being situated in the new postal district designated by the letter W, members, in their correspondence with the Secretary, are requested to subjoin that letter to the usual address.

GENERAL MEETING in London, in December, 1860.

GENERAL MEETING in London, May 22, 1861, at Twelve o'clock.

COUNTRY MEETING at Leeds, in 1861.

MONTHLY COUNCIL (for transaction of business), at 12 o'clock on the first Wednesday in every month, excepting January, September, and October: open only to Members of Council and Governors of the Society.

WEEKLY COUNCIL (for practical communications), at 12 o'clock on all Wednesdays in February, March, April, May, June, and July, excepting the first Wednesday in each of those months, and during adjournment: open to all Members of the Society, who are particularly invited by the Council to avail themselves of this privilege.

ADJOURNMENTS.—The Council adjourn over Easter, Passion, and Whitsun weeks, when those weeks do not include the first Wednesday of the month; from the first Wednesday in August to the first Wednesday in November; and from the first Wednesday in December to the first Wednesday in February.

DISEASES of Cattle, Sheep, and Pigs.—Members have the privilege of applying to the Veterinary Committee of the Society; and of sending animals to the Royal Veterinary College, on the same terms as if they were subscribers to the College.—(A statement of these privileges will be found in the present Appendix, p. xxxii.)

CHEMICAL ANALYSIS.—The privileges of Chemical Analysis enjoyed by Members of the Society will be found stated in the Appendix of the present volume, p. xxxi.

LOCAL CHEQUES.—Members are particularly requested not to forward Country Cheques for payment in London; but London Cheques, or Post-office Orders on Old Cavendish-street (payable to H. HALL DARE), in lieu of them. All Cheques are required to bear upon them a penny draft or receipt stamp, which must be cancelled in each case by the initials of the drawer. They may also conveniently transmit their Subscriptions to the Society, by requesting their Country Bankers to pay (through their London Agents) the amount at the Society's Office (No. 12, Hanover Square, London), between the hours of ten and four, when official receipts, signed by the Secretary, will be given for such payments.

NEW MEMBERS.—Every candidate for admission into the Society must be proposed by a Member; the proposer to specify in writing the full name, usual place of residence, and post-town, of the candidate, either at a Council meeting, or by letter addressed to the Secretary.

PACKETS BY POST.—Packets not exceeding two feet in length, width, or depth, consisting of written or printed matter (but not containing letters sealed or open), if sent without envelopes, or enclosed in envelopes open at each end, may be forwarded by the inland post, if stamped, at the following rates:—

For a packet not exceeding	4	ounces	(or quarter of a pound) . . .	1 penny.
" " "	8	"	(or half a pound)	2 pence.
" " "	16	"	(or one pound)	4 "
" " "	24	"	(or one pound and a half) . .	6 "
" " "	32	"	(or two pounds)	8 "

[And so on in the proportion of 8 ounces for each additional 2*d*.]

*** Members may obtain on application to the Secretary copies of an Abstract of the Charter and Bye-Laws, of a Statement of the General Objects, &c., of the Society, of Chemical and Veterinary Privileges, and of other printed papers connected with special departments of the Society's business.

Royal Agricultural Society of England.

GENERAL MEETING,

12, Hanover Square, Tuesday, May 22, 1860.

REPORT OF THE COUNCIL.

The Society consists, at the present time, of—

72 Life Governors,
119 Annual Governors,
927 Life Members,
4,047 Annual Members,

making a total of 5,165 names on the list.

The finances of the Society have on no former occasion been in so favourable a condition.

The dividend on the estate of the late Secretary amounts to 970*l.* 11*s.* 10*d.*, being at the rate of 10*s.* 11½*d.* in the pound, which has been paid into the Society's bankers.

The funded capital, which stood at 10,000*l.*, has been raised by further investment to the amount of 12,000*l.* in the New Three per Cents.

The Finance Committee have appointed Messrs. Quilter and Ball to be the Professional Accountants of the Society, who by frequent and close examination of the books and accounts will materially assist the Committee.

The Council have elected Professor Voelcker, the Society's Consulting Chemist, to be an honorary member of the Society.

The Consulting Chemist is engaged in investigations on the following subjects:—

Field Experiments on Wheat, Barley, and Turnips.
The Action of Simple Saline Compounds on the Soil.
The Feeding Value and Composition of Mangold Pulp.
The Chemistry of Cheese and Butter.

The Council having determined to select a literary and scientific Editor of the Society's Journal, have appointed Mr. Philip H. Frere to that office, and, from the high testimonials exhibited by that gentleman, feel confidence in hoping that he will succeed in conducting the Society's publications with efficiency and talent.

The arrangements for the Canterbury Meeting, to be held during the week commencing the 9th of July, are proceeding satisfactorily. The Implement Yard will contain nearly a mile and a quarter of Shedding, in addition to a very large entry of Machinery in motion; and the entry of Stock, which will close on the 1st of June, is already large.

The Council, in the spirit which has guided them on former occasions, and considering the cordial reception which awaits them in the county of Kent, have thought they could not do otherwise than defer to the strongly-expressed wishes of the locality, that this special opportunity should not be lost for directing attention to the agriculture peculiar to the district, and have been induced to accept the offer of a considerable sum, to be distributed in prizes for Ploughing on the Kentish or turnrise system, as also for Hops, Wool, and certain Breeds of Live Stock.

The Council have decided, subject to the usual conditions, to hold the Society's Country Meeting next year at Leeds, for the district comprising the three Ridings of Yorkshire. Great anxiety was evinced by many localities in the county, to be selected as the place for the Country Meeting; but the advantages of Leeds and its neighbourhood, joined to the eligibility of the sites offered for Showyard and Trial-fields, have induced a decision in its favour, which it is confidently hoped will result in a most successful meeting.

In conclusion, the Council trust that the Society will prove itself to be in a position to pursue its career with renewed energy, and that its future may be marked by increased endeavours to advance the important objects for which it was specially constituted.

By Order of the Council,

H. Hall Dare,

Secretary.

ROYAL AGRICULTURAL SOCIETY OF ENGLAND.

HALF-YEARLY ACCOUNT, EXTENDING FROM THE 1ST OF JULY TO THE 31ST OF DECEMBER, 1859.

RECEIPTS.	£.	s.	d.	PAYMENTS.	£.	s.	d.
Balance in the hands of the Bankers, July 1, 1859	2047	18	7	Establishment, including Rent, Rates, and Salaries	482	5	4
Petty Cash Balance in hand, July 1, 1859	6	8	1	Postage and Carriage	14	10	1
Dividends on Stock	141	17	6	Advertisements	1	18	0
Governors' Life Composition	50	0	0	Journal	964	14	7
Governors' Subscriptions	50	0	0	Essay Prizes	50	0	0
Members' Life-Compositions	125	0	0	Veterinary Grant (extra)	25	0	0
Members' Subscriptions	409	2	0	Chemical Grant	150	0	0
Journal	231	11	3	Subscription returned (paid in error)	1	0	0
Country Meeting (Warwick)	5407	13	6	Country Meeting (Warwick)	5432	13	9
Sale of Sundries	8	2	6	Sundry items of Petty Cash	3	12	4
				Petty Cash not accounted for by late Secretary	9	7	0
				Balance in the hands of the Bankers, Dec. 31, 1859	1339	8	0
				Petty-Cash Balance in hand, Dec. 31, 1859	3	4	4
	£8477	13	5		£8477	13	5

(Signed) A. N. HOOD, WILLIAM FISHER HOBBS, R. MILWARD, *Finance Committee.*

Examined, audited, and found correct, this 18th day of May, 1860.

(Signed) WILLIAM ASTBURY, JOSEPH DRUCE, HENRY CORBET, *Auditors on the part of the Society.*

SHOW AT CANTERBURY: JULY, 1860.

STEWARDS OF THE YARD.

Stewards of Cattle.
Mr. Milward.
Mr. Fisher Hobbs.
Hon. W. G. Cavendish, M.P.

Stewards of Implements.
Mr. H. B. Caldwell.
Mr. Edw. Pope.
Lord Leigh.

Honorary Director of the Show.
B. T. Brandreth Gibbs.

JUDGES.

Short-horns.
Charles Barnett,
J Parkinson,
G. Atkinson.

Herefords.
E. L. Franklin,
G. W. Baker,
H. Higgins.

Devons.
J. Anstey,
Thomas Potter.

Other Breeds and Sussex.
William Ladds,
A. Denman,
B. Swaffield.

Horses.
John Atkinson,
W. Bartholomew,
E. Greene.

Riding Horses and Ponies.
Hon. Colonel Cotton,
J. Earle Welby,
H. Thurnall.

Leicester Sheep.
R. Hewitt,
T. Harris,
R. B. Aylmer.

Long-woolled Sheep, Kentish and Local Prizes.
Thomas Brown,
J. Abbot,
H. Beevor.

Southdown Sheep.
Henry Lugar,
J. G. Homer,
P. Purves.

Short-woolled Sheep.
J. Rawlence,
G. Brown,
H. Beauford.

Shropshire Down Sheep.
C. Randall,
W. Kempe Bourne,
E. Trumper.

Pigs.
Rev. E. Elmhirst,
J. Unthank,
W. Cattle.

Implements.

Steam Ploughs.
Owen Wallis,
William Owen, C.E.,
Professor John Wilson.

Thrashing Machines.
John Brasnett,
Joseph Druce.

Mills and Bone Mill Crushers and Chaff Cutters.

Hand Power.	Steam Power.
John Hicken,	Fielder King,
G. M. Hipwell.	Edw. Whittle.

Miscellaneous.
John Clarke,
William Tindall.

Local Prizes.
F. Rammell,
F. Murton,
Thomas Abbott,
H. G. Austin,
P. S. Punnett.

Veterinary-Inspectors.
Professor Simonds,
Professor Spooner.

Consulting-Engineer.
Charles Edwards Amos,
(Firm of Easton and Amos).

AWARD OF PRIZES.

CATTLE: *Short-Horns.*

LIEUTENANT-COLONEL CHARLES TOWNELEY, of Towneley Park, Burnley, Lancaster: the Prize of THIRTY SOVEREIGNS, for his 2 years 10 months 2 weeks and 5 days-old Bull; bred by exhibitor.

JAMES DICKINSON, of Balcony Farm-house, Upholland, Wigan, Lancaster: the Prize of FIFTEEN SOVEREIGNS, for his 3 years 1 month and 2 weeks-old Bull; bred by exhibitor.

LORD FEVERSHAM, of Duncombe Park, Helmsley, Yorkshire: the Prize of FIVE SOVEREIGNS, for his 4 years and 2 months-old Bull; bred by exhibitor.

JONATHAN PEEL, of Knowlmere Manor, Clitheroe, Yorkshire: the Prize of TWENTY-FIVE SOVEREIGNS, for his 1 year 4 months 1 week and 1 day-old Bull; bred by exhibitor.

FRANCIS HAWKSWORTH FAWKES, of Farnley Hall, Otley, Yorkshire: the Prize of FIFTEEN SOVEREIGNS, for his 1 year 3 months and 4 days-old Bull; bred by exhibitor.

SIR CHARLES TEMPEST, Bart., of Broughton Hall, Skipton, Yorkshire: the Prize of FIVE SOVEREIGNS, for his 1 year 5 months and 1 day-old Bull; bred by exhibitor.

STEWART MARJORIBANKS, of Bushey Grove, Watford, Herts: the Prize of TEN SOVEREIGNS, for his 10 months and 3 weeks-old Bull-calf; bred by exhibitor.

LIEUTENANT-COLONEL TOWNELEY: the Prize of FIVE SOVEREIGNS, for his 11 months 1 week and 5 days-old Bull-calf; bred by exhibitor.

RICHARD EASTWOOD, of Swinshawe House, Burnley, Lancashire: the Prize of TWENTY SOVEREIGNS, for his 4 years and 5 days-old Cow, In-milk and In-calf; bred by William Wetherell, of Aldborough, Darlington, Yorkshire.

RICHARD BOOTH, of Warlaby, Northallerton, Yorkshire: the Prize of TEN SOVEREIGNS, for his 4 years 8 months 3 weeks and 3 days-old Cow, In-milk and In-calf; bred by exhibitor.

LADY PIGOT, of Branches Park, Newmarket, Suffolk: the Prize of FIVE SOVEREIGNS, for her 3 years 5 months and 1 week-old Cow, In-calf; bred by Jonas Webb, of Babraham, Cambridge.

HENRY AMBLER, of Watkinson Hall, Halifax, Yorkshire: the Prize of FIFTEEN SOVEREIGNS, for his 2 years 1 month 1 week and 5 days-old Cow, In-calf; bred by exhibitor.

CAPTAIN GUNTER, of The Grange, Wetherby, Yorkshire: the Prize of TEN SOVEREIGNS, for his 2 years 7 months and 6 days-old Cow, In-calf: bred by exhibitor.

LADY PIGOT: the Prize of FIVE SOVEREIGNS, for her 2 years 9 months 4 days-old Heifer, In-calf; bred by Mr. Wetherell.

CAPTAIN GUNTER: the Prize of FIFTEEN SOVEREIGNS, for his 1 year 11 months 1 week and 5 days-old twin-Heifer; bred by exhibitor.

CAPTAIN GUNTER: the Prize of TEN SOVEREIGNS, for his 1 year 11 months 1 week and 5 days-old Yearling Heifer; bred by exhibitor.

JOSEPH ROBINSON, of Clifton Pastures, Newport Pagnell, Buckingham: the Prize of FIVE SOVEREIGNS, for his 1 year 1 month and 3 weeks-old Heifer; bred by exhibitor.

Cattle: *Herefords.*

Thomas Edwards, of Wintercott, Leominster, Hereford: the Prize of Thirty Sovereigns, for his 2 years 9 months 2 weeks and 2 days-old Bull: bred by exhibitor.

John Williams, of St. Mary's, Kingsland, Leominster, Hereford: the Prize of Fifteen Sovereigns, for his 3 years 10 months and 4 days-old Bull; bred by exhibitor.

Thomas Rea, of Westonbury, Pembridge, Hereford: the Prize of Five Sovereigns, for his 2 years 8 months and 2 weeks-old Bull; bred by exhibitor.

William Perry, of Cholstrey, Leominster, Hereford: the Prize of Twenty-five Sovereigns, for his 1 year 9 months and 1 day-old Bull; bred by exhibitor.

Thomas Rea: the Prize of Fifteen Sovereigns, for his 1 year and 8 months-old Bull; bred by exhibitor.

Lord Berwick, Cronkhill, Shrewsbury: the Prize of Five Sovereigns, for his 1 year 11 months and 4 days-old Bull; bred by exhibitor.

John Monkhouse, of The Stowe, Hereford: the Prize of Ten Sovereigns, for his 10 months 3 weeks and 1 day-old Bull-calf: bred by exhibitor.

Thomas Edwards: the Prize of Five Sovereigns, for his 10 months and 6 days-old Bull-calf; bred by exhibitor.

James Taylor, of Stretford Court, Leominster: the Prize of Twenty Sovereigns, for his 6 years 10 months and 6 days-old Cow, In-milk and supposed to be In-calf; bred by John Taylor, of Burton Cottage, Leominster.

James Rea, of Monaughty, Knighton, Radnor: the Prize of Fifteen Sovereigns, for his 2 years 11 months and 4 days-old Heifer, In-milk and In-calf; bred by exhibitor.

John Williams: the Prize of Ten Sovereigns, for his 2 years and 10 months-old In-calf Heifer; bred by exhibitor.

Lord Berwick: the Prize of Five Sovereigns, for his 2 years 9 months and 2 weeks-old In-calf Heifer; bred by exhibitor.

Lord Bateman, of Shobdon Court, Shobdon, Hereford: the Prize of Fifteen Sovereigns, for his 1 year 11 months and 2 weeks-old Yearling Heifer; bred by exhibitor.

Edmond Wright, of Halston Hall, Oswestry, Shropshire: the Prize of Ten Sovereigns, for his 1 year 11 months and 5 days-old Yearling Heifer; bred by exhibitor.

Philip Turner, of Leen, Pembridge, Hereford: the Prize of Five Sovereigns, for his 1 year 6 months 1 week and 3 days-old Yearling Heifer; bred by exhibitor.

John Williams: the Prize of Ten Sovereigns, for his 8 months and 3 weeks-old Heifer-calf; bred by exhibitor.

Cattle: *Devons.*

Thomas and John Palmer, of Norton, Stoke Climsland, Callington, Cornwall: the Prize of Thirty Sovereigns, for his 3 years 3 months 3 weeks and 2 days-old Bull; bred by James Quartly, of Molland, South Molton.

George Turner, of Barton, near Exeter: the Prize of Ten Sovereigns, for his 2 years and 9 months-old Bull; bred by exhibitor.

John Bodley, of Stockley Pomeroy, Crediton, Devon: the Prize of Fifteen Sovereigns, for his 2 years and 1 month-old Bull; bred by exhibitor.

James Quartly, of Molland House, Southmolton, Devon: the Prize of Twenty-five Sovereigns, for his 1 year 2 months and 3 weeks-old Bull; bred by exhibitor.

James Quartly: the Prize of Fifteen Sovereigns, for his 1 year and 6 months-old Bull; bred by exhibitor.

George Turner: the Prize of Five Sovereigns, for his 1 year and 7 months-old Bull; bred by exhibitor.

George Turner: the Prize of Ten Sovereigns, for his 8 months and 2 weeks-old Bull-Calf; bred by exhibitor.

William Hole, of Hannaford, Barnstaple, Devon: the Prize of Five Sovereigns, for his 6 months and 3 weeks-old Bull-Calf; bred by exhibitor.

James Quartly: the Prize of Twenty Sovereigns, for his 5 years and 2 months-old In-milk and In-calf Cow; bred by exhibitor.

George Turner: the Prize of Ten Sovereigns, for his 3 years and 8 months-old In-calf Cow; bred by exhibitor.

George Turner: the Prize of Five Sovereigns, for his 5 years 5 months and 2 weeks-old In-milk and In-calf Cow; bred by exhibitor.

George Turner: the Prize of Fifteen Sovereigns, for his 2 years and 8 months-old In-Calf Heifer; bred by exhibitor.

John Mildon, of Woodington Farm, Witheridge, Devon: the Prize of Ten Sovereigns, for his 2 years 11 months and 3 weeks-old In-calf Heifer; bred by exhibitor.

John Quartly: the Prize of Five Sovereigns, for his 2 years 1 month and 3 weeks-old In-calf Heifer; bred by exhibitor.

Philip Halse, of Molland, Southmolton, Devon: the Prize of Fifteen Sovereigns, for his 1 year and 8 months-old Yearling Heifer; bred by exhibitor.

Philip Halse: the Prize of Ten Sovereigns, for his 1 year 8 months 3 weeks and 4 days-old Yearling Heifer; bred by exhibitor.

Edward Pope, of Great Toller, Maiden Newton, Dorset: the Prize of Five Sovereigns, for his 1 year 7 months and 1 week-old Yearling Heifer; bred by exhibitor.

George Turner: the Prize of Ten Sovereigns, for his 7 months and 2 weeks-old Heifer-Calf; bred by exhibitor.

Cattle: *Other established Breeds.*

Edward Cane, of Berwick Court, Berwick: the Prize of Ten Sovereigns, for his 2 years and 5 months-old Sussex Bull; bred by John Verrall, of Swanborough, Lewes.

Lord Sondes, of Elmham Hall, Thetford, Norfolk: the Prize of Ten Sovereigns, for his 1 year and 8 months-old Norfolk polled Bull; bred by exhibitor.

Edward Cane: the Prize of Ten Sovereigns, for his 8 years and 6 months-old In-milk and In-calf Sussex Cow; bred by Josiah Pitcher, Westham, Hailsham, Sussex.

Lord Sondes: the Prize of Ten Sovereigns, for his 2 years 3 months and 2 weeks-old In-calf Norfolk polled Heifer; bred by exhibitor.

Samuel Camfield Baker, of The Pheasantry, Beaufort-street, Chelsea, Middlesex: the Prize of Five Sovereigns, for his under 3 years-old In-calf Bretonne Cow; breeder unknown.

Horses: *Agricultural.*

Rev. Stephen Terry, of Dummer, Basingstoke, Hants: the Prize of Twenty-five Sovereigns, for his 5 years 2 months and 2 weeks-old Bay Stallion; bred by exhibitor.

Samuel Clayden, of Little Linton, Cambridge: the Prize of Fifteen Sovereigns, for his 5 years-old Suffolk Stallion: bred by exhibitor.

Jonas Webb, of Babraham, Cambridge: the Prize of Five Sovereigns, for his 5 years 1 month 1 or 2 days-old Suffolk Stallion; bred by exhibitor.

NATHANIEL GEORGE BARTHROPP, of Cretingham Rookery, Wickham Market, Suffolk: the Prize of TWENTY SOVEREIGNS, for his 2 years-old Suffolk Stallion; bred by exhibitor.

WILLIAM WELLS, of Redleaf, Penshurst, Kent: the Prize of TEN SOVEREIGNS, for his 2 years 2 months 3 weeks and 6 days-old Suffolk Stallion; bred by Lord Warwick, of Warwick Castle.

ISAAC RIST, of Tattingstone, Ipswich: the Prize of TWENTY-FIVE SOVEREIGNS, for his 9 years-old Suffolk Mare; bred by Mr. Lambert, of Bucklesham, Ipswich.

GEORGE CARTER, of Danbury, Chelmsford: the Prize of TEN SOVEREIGNS, for his 4 years-old (foal 4 months 1 week) pure Suffolk Mare: bred by Charles Carter, Stow Marris, Maldon, Essex.

NATHANIEL GEORGE BARTHROPP: the Prize of FIFTEEN SOVEREIGNS, for his 2 years-old Suffolk Mare; bred by Mr. Bucke, of Cretingham, Wickham Market.

JOHN CLAYDEN, of Littlebury, Saffron Walden, Essex: the Prize of TEN SOVEREIGNS, for his 2 years-old Suffolk Mare; bred by the Trustees of the late W. C. Clayden, of Barham Hall, Linton, Cambridge.

DRAY-HORSES.

EDMUND OLDING, of Ratfin, Amesbury, Wilts: the Prize of TWENTY-FIVE SOVEREIGNS, for his 3 years 1 month 2 weeks and 4 days-old Stallion; bred by exhibitor.

GEORGE BROWN, of Little Hinton, Shrivenham, Wilts: the Prize of TEN SOVEREIGNS, for his 4 years 1 month and 2 weeks-old Stallion; bred by Jos. Gay, of Swindon, Wilts.

WILLIAM ROOT, of Chipping Warden, Banbury, Oxon: the Prize of FIFTEEN SOVEREIGNS, for his 2 years 2 weeks and 4 days-old Stallion; bred by Thomas Johnson, of Priors Marston, Rugby, Warwick.

JOHN BROWN, of Compton, Newbury, Berks: the Prize of FIVE SOVEREIGNS, for his 2 years 1 month and 1 week-old Stallion; bred by Mr. Hall, of Woolhampton, Newbury, Berks.

OTHER HORSES.

EDWARD MARJORIBANKS, of Greenlands, Henley-on-Thames, Oxon: the Prize of TWENTY-FIVE SOVEREIGNS, for his 10 years and 6 months-old thorough-bred Stallion; bred by the Duke of Richmond, Goodwood, Chichester.

GEORGE TRUMPER, of Horton, Slough, Bucks: the Prize of FIFTEEN SOVEREIGNS, for his 4 years-old thorough-bred Stallion; bred by Mr. Simpson, Roydon, Diss, Norfolk.

JOHN DENCHFIELD, of Aston Abbotts, Aylesbury, Bucks: the Prize of TWENTY SOVEREIGNS, for his 11 years-old brood Mare; bred by exhibitor.

ROBERTSON RUSE, of Jealotts Hall, Warfield, Bracknell, Berks: the Prize of TEN SOVEREIGNS, for his 11 years-old brood Mare; bred by John Marsh, of North End, Little Yeldham, Halstead, Essex.

WALTER JOHN BURCH, of Campsey Ash, Wickham Market, Suffolk: the Prize of FIFTEEN SOVEREIGNS, for his 8 years-old hackney Mare; bred by Mr. Stebbins, of Narborough, Swaffham, Norfolk.

SHEEP: *Leicesters.*

WILLIAM SANDAY, of Holme Pierrepont, Nottingham: the Prize of TWENTY SOVEREIGNS, for his about 16 months-old Ram; bred by exhibitor.

WILLIAM SANDAY: the Prize of TEN SOVEREIGNS, for his about 16 months-old Ram; bred by exhibitor.

William Sanday: the Prize of Five Sovereigns, for his 16 months-old Ram; bred by exhibitor.

William Sanday: the Prize of Twenty Sovereigns, for his 4 years and 4 months-old Ram; bred by exhibitor.

William Sanday: the Prize of Ten Sovereigns, for his 2 years and 4 months-old Ram; bred by exhibitor.

William Sanday: the Prize of Five Sovereigns, for his 2 years and 4 months-old Ram; bred by exhibitor.

William Sanday: the Prize of Twenty Sovereigns, for his 16 months-old Pen of 5 Shearling Ewes; bred by exhibitor.

Lieutenant-Colonel Inge, of Thorpe Constantine, Tamworth: the Prize of Ten Sovereigns, for his 1 year 3 months and 2 weeks-old Pen of five Shearling Ewes; bred by exhibitor.

George Turner, of Barton, near Exeter: the Prize of Five Sovereigns, for his 1 year 3 months and 1 week-old Pen of five Shearling Ewes; bred by exhibitor.

Sheep: *Southdowns.*

Jonas Webb, of Babraham, Cambridge: the Prize of Twenty Sovereigns, for his 1 year and 4 months-old Ram; bred by exhibitor.

Jonas Webb: the Prize of Ten Sovereigns, for his 1 year and 4 months-old Ram; bred by exhibitor.

Jonas Webb: the Prize of Five Sovereigns, for his 1 year and 4 months-old Ram; bred by exhibitor.

Jonas Webb: the Prize of Twenty Sovereigns, for his 2 years and 4 months-old Ram; bred by exhibitor.

Jonas Webb: the Prize of Ten Sovereigns, for his 2 years and 4 months-old Ram; bred by exhibitor.

Jonas Webb: the Prize of Five Sovereigns, for his 2 years and 4 months-old Ram; bred by exhibitor.

John and Alfred Heasman, of Angmering, Arundel, Sussex: the Prize of Twenty Sovereigns, for their 1 year 4 months and 2 weeks-old Pen of five Shearling Ewes; bred by exhibitors.

Lord Walsingham, of Merton Hall, Thetford, Norfolk: the Prize of Ten Sovereigns, for his 1 year and 4 months-old Pen of five Shearling Ewes: bred by exhibitor.

Duke of Richmond, of Goodwood, Chichester, Sussex: the Prize of Five Sovereigns, for his 1 year and 4 months-old Pen of five Shearling Ewes; bred by exhibitor.

Sheep: *Kentish or Romney Marsh.*

Frederick Murton, of Smeeth, Ashford, Kent: the Prize of Fifteen Sovereigns, for his 1 year and 3 months-old Ram; bred by exhibitor.

Frederick Murton: the Prize of Five Sovereigns, for his 1 year and 3 months-old Ram; bred by exhibitor.

Frederick Murton: the Prize of Five Sovereigns added by the Local Committee, for his 1 year and 3 months-old Ram; bred by exhibitor.

Frederick Murton: the Prize of Fifteen Sovereigns, for his 3 years and 3 months-old Ram; bred by exhibitor.

Frederick Murton: the Prize of Five Sovereigns, for his 2 years and 3 months-old Ram; bred by exhibitor.

Frederick Murton: the Prize of Five Sovereigns, added by the Local Committee, for his 4 years and 3 months-old Ram; bred by exhibitor.

William Gascoyne, of Bapchild, Sittingbourne, Kent: the Prize of Fifteen Sovereigns, for his 1 year 3 months and 1 week-old Pen of five Shearling Ewes; bred by exhibitor.

Charles Neve, of Shepway Court, Maidstone, Kent: the Prize of Five Sovereigns, for his 1 year 2 months and 3 weeks-old Pen of five Shearling Ewes; bred by exhibitor.

Frederick Murton: the Prize of Five Sovereigns, added by the Local Committee, for his 1 years and 3 months-old Pen of five Shearling Ewes; bred by exhibitor.

Sheep: *Long-woolled.*

James Walker, of Northleach, Gloucestershire: the Prize of Twenty Sovereigns, for his 1 year and 3 months-old Shearling Ram; bred by exhibitor.

Robert Garne, of Aldsworth, Northleach, Gloucestershire: the Prize of Ten Sovereigns, for his 1 year and 4 months-old Shearling Cotswold Ram; bred by exhibitor.

Robert Garne: the Prize of Five Sovereigns, for his 1 year and 4 months-old Shearling Cotswold Ram; bred by exhibitor.

Robert Garne: the Prize of Twenty Sovereigns, for his 3 years and 4 months-old Cotswold Ram; bred by the late William Garne of Aldsworth.

Robert Garne: the Prize of Ten Sovereigns, for his 3 year and 3 months-old Cotswold Ram; bred by the late William Garne of Aldsworth.

George Fletcher, of Shipton Sollars, near Cheltenham, Gloucestershire: the Prize of Five Sovereigns, for his 3 years 3 months and 2 weeks-old Cotswold Ram; bred by exhibitor.

William Lane, of Broadfield Farm, Northleach, Gloucestershire: the Prize of Twenty Sovereigns, for his 1 year 3 months and 2 weeks-old Pen of five Shearling Cotswold Ewes; bred by exhibitor.

William Lane: the Prize of Ten Sovereigns, for his 1 year and 4 months-old Pen of five Shearling Cotswold Ewes; bred by exhibitor.

William Lane: the Prize of Five Sovereigns, for his 1 year 3 months and 3 weeks-old Pen of five Shearling Cotswold Ewes; bred by exhibitor.

Sheep: *Shropshire.*

Thomas Horton, of Harnage Grange, Shrewsbury: the Prize of Fifteen Sovereigns, for his 1 year and 3½ months-old Shearling Ram; bred by exhibitor.

James and Edward Crane, of Shrawardine, Shrewsbury: the Prize of Five Sovereigns, for their 1 year and 3-months-old Shearling Ram; bred by exhibitors.

Sampson Byrd, of Lees Farm, Stafford: the Prize of Fifteen Sovereigns, for his 2 years 3 months and 3 weeks-old Ram; bred by exhibitor.

Thomas Horton: the Prize of Five Sovereigns, for his 3 years 3 months and 3 weeks-old Ram; bred by exhibitor.

James and Edward Crane: the Prize of Fifteen Sovereigns, for their 1 year 2 months and 3 weeks-old Pen of five Shearling Ewes; bred by exhibitors.

James and Edward Crane: the Prize of Five Sovereigns, for their 1 year and 3 months-old Pen of five Shearling Ewes; bred by exhibitors.

Sheep: *Short-woolled.*

Stephen King, of Old Hayward Farm, Hungerford, Berks: the Prize of Twenty Sovereigns, for his 1 year 4 months and 2 weeks-old West Country Down Shearling Ram: bred by exhibitor.

William Humfrey, of Oak Ash, Chaddleworth, Wantage, Berks: the Prize of Ten Sovereigns, for his 1 year 4 months and 2 weeks-old West Country Down Shearling Ram; bred by exhibitor.

William Humfrey: the Prize of Five Sovereigns, for his 1 year 5 months and 1 week-old West Country Down Shearling Ram; bred by exhibitor.

William Humfrey: the Prize of Twenty Sovereigns, for his 2 years 5 months and 2 weeks-old West Country Down Ram; bred by exhibitor.

William Humfrey: the Prize of Ten Sovereigns, for his 3 years 4 months and 1 week-old West Country Down Ram; bred by exhibitor.

William Humfrey: the Prize of Five Sovereigns, for his 2 years 4 months and 1 week-old West Country Down Ram; bred by exhibitor.

William Browne Canning, of Chisledon, Swindon, Wilts: the Prize of Twenty Sovereigns, for his 1 year 4 months and 2 weeks-old Pen of five West Country Down Shearling Ewes; bred by exhibitor.

Stephen King: the Prize of Ten Sovereigns, for his 1 year 4 months and 2 weeks-old Pen of five West Country Down Shearling Ewes; bred by exhibitor.

William F. Bennett, of Chilmark, Salisbury: the Prize of Five Sovereigns, for his 1 year 4 months and 2 weeks-old Pen of five Improved Hampshire Down Shearling Ewes; bred by exhibitor.

Pigs.

John Harrison, jun., of Heaton-Norris, Stockport, Lancashire: the Prize of Ten Sovereigns, for his 2 years 11 months and 2 days-old white with spots large Boar; bred by John Goodwin, of High Lane, Stockport.

John Dyson, of Adelphi Hotel, Dock-street, Leeds, Yorkshire: the Prize of Five Sovereigns, for his 2 years 11 months 1 week and 2 days-old large white Boar; bred by Mr. Grisewood, of Market Weighton, Yorkshire.

John Harrison, jun.: the Prize of Ten Sovereigns, for his 1 year 5 months 4 weeks and 1 day-old small Boar; bred by exhibitor.

George Mangles, of Givendale, Ripon, Yorkshire: the Prize of Five Sovereigns, for his 3 years 2 months and 1 day-old Yorkshire and Cumberland small Boar.

Thomas Crisp, of Butley Abbey, Wickham Market, Suffolk: the Prize of Ten Sovereigns, for his 2 years 3 months 2 weeks and 4 days-old small-breed black Suffolk Boar; bred by exhibitor.

Thomas Crisp: the Prize of Five Sovereigns, for his 2 years 1 week and 4 days-old small-breed black Suffolk Boar; bred by exhibitor.

William Bradley Wainman, of Carhead, Cross Hills, Yorkshire: the Prize of Ten Sovereigns, for his about 2 years and 3 months-old white Yorkshire Boar; breeder unknown.

Henry Endeacott, of Norfolk-street, Hunslett-lane, Leeds: the Prize of Five Sovereigns, for his 1 year 10 months 2 weeks and 5 days-old white Boar; bred by exhibitor.

James Clayton, of Midway Farm, Poynton, near Stockport: the Prize of Ten Sovereigns, for his 2 years 5 months and 3 weeks-old large-breed white Cheshire Sow; bred by Sir James Watts, of Abney Hall, Cheadle, near Stockport, Cheshire.

William Bradley Wainman: the Prize of Five Sovereigns, for his 2 years 4 months and 2 weeks-old large-breed white Carhead Sow; bred by exhibitor.

William Hatton, of Addingham, near Leeds: the Prize of Ten Sovereigns, for his 2 years 2 weeks and 4-days-old small-breed white Sow; bred by exhibitor.

Edward Ludd Betts, of Preston Hall, Maidstone, Kent: the Prize of Five Sovereigns, for his 1 year and 8 months-old small-breed white Suffolk Sow: bred by exhibitor.

George Mumford Sexton, of Earl's Hall, Cockfield, Sudbury, Suffolk: the Prize of Ten Sovereigns, for his 3 years and 4 months-old small-breed black Suffolk Sow; bred by exhibitor.

Thomas Crisp: the Prize of Five Sovereigns, for his 1 year 8 months and 3 weeks-old Improved Suffolk Sow; bred by exhibitor.

John Harrison, jun.: the Prize of Ten Sovereigns, for his 3 years 2 months and 2 days-old white with spots Sow; bred by Mr. Robinson, of Lee Green Hall, Middlewich, Cheshire.

George Mangles: the Prize of Five Sovereigns, for his 4 years 3 months and 2-days old white Cumberland and Yorkshire Sow; bred by exhibitor.

William Hewer, of Sevenhampton, Highworth, Wilts: the Prize of Ten Sovereigns, for his 7 months and 3 weeks-old Pen of three black and white Berkshire Sow-pigs; bred by exhibitor.

William Hewer: the Prize of Five Sovereigns, for his 7 months and 2 weeks-old Pen of three white Berkshire Sow-pigs; bred by exhibitor.

Thomas Crisp: the Prize of Ten Sovereigns, for his 7 months and 3 weeks-old Pen of three small-breed white Suffolk Sow-pigs: bred by exhibitor.

Samuel Wiley, of Brandsby, York: the Prize of Five Sovereigns, for his 6 months 2 weeks and 4 days-old Pen of three small-breed pure white Yorkshire Sow-pigs; bred by exhibitor.

Georgr Mumford Sexton, of Earl's Hall, Cockfield, Sudbury, Suffolk: the Prize of Ten Sovereigns, for his 7 months-old Pen of three small-breed black Suffolk Sow-pigs; bred by exhibitor.

Thomas Crisp: the Prize of Five Sovereigns, for his 7 months 2 weeks and 4 days-old Pen of three small breed Improved black Suffolk Sow-pigs; black and white bred by exhibitor.

Edward Ludd Betts, of Preston Hall, near Maidstone, Kent: the Prize of Ten Sovereigns, for his 6 months 4 weeks and 1 day-old Pen of three black and white Improved Aylesford Sow-pigs; bred by exhibitor.

Edward Davies, jun., of Harrington, Shiffnal, Shropshire: the Prize of Five Sovereigns, for his 4 months 2 weeks and 4 days-old Pen of three white Sow-pigs; bred by exhibitor.

Special Prizes,

GIVEN BY THE CANTERBURY LOCAL COMMITTEE.

Cattle: *Sussex.*

William Botting, of Westmeston Place, Hurstpierpoint, Sussex: the Prize of Thirty Sovereigns, for his 5 years 1 week and 2 days-old Bull; bred by exhibitor.

George Buss, of Boughton Aluph, Ashford, Kent: the Prize of Fifteen Sovereigns, for his 4 years and 3 months-old Bull; bred by William Gower, of Hellingly, Hurst Green, Sussex.

Stephen Hart, of Aldington Court, Hythe, Kent: the Prize of Six Sovereigns, for his 3 years 2 months and 2 weeks-old Bull: bred by T. Barton, formerly of Pebsham Farm, Bexhill, Sussex.

William Dunk, of Horton Priory, Hythe, Kent: the Prize of Twenty-five Sovereigns, for his 1 year 6 months 1 week and 4 days-old Bull; bred by exhibitor.

Tilden Smith, of Beckley, Staplehurst, Sussex: the Prize of Fifteen Sovereigns, for his 1 year 3 months and 1 week-old Bull; bred by exhibitor.

Tilden Smith: the Prize of Twenty Sovereigns, for his 4 years 3 months 2 weeks and 3 days-old In-calf Cow; bred by exhibitor.

GEORE JENNER, of Parsonage House, Udimore, Rye, Sussex: the Prize of TEN SOVEREIGNS, for his 3 years 6 months 2 weeks and 5 days-old In-milk and In-calf Cow; bred by exhibitor.

THOMAS HAYLEY GREGSON, of Woodsden, Hawkhurst, Kent: the Prize of FIVE SOVEREIGNS, for his 8 years and 6 months-old In-milk Cow; bred by Charles Pilcher, of Freizingham, Rolvenden, Kent.

JOHN and ALFRED HEASMAN, of Angmering, Arundel, Sussex: the Prize of FIFTEEN SOVEREIGNS, for their 2 years 5 months and 3 weeks-old In-calf Heifer; bred by exhibitors.

THOMAS HAYLEY GREGSON: the Prize of TEN SOVEREIGNS, for his 2 years 3 months and 4 days-old In-calf Heifer; bred by exhibitor.

PENNINGTON GORRINGE, of Tilton, Selmeston, Lewes, Sussex: the Prize of FIVE SOVEREIGNS, for his 2 years 5 months and 4 days-old In-calf Heifer; bred by James and Pennington Gorringe, of Tilton.

ROBERT NEAME, of Fairbrook, Faversham, Kent: the Prize of FIFTEEN SOVEREIGNS, for his 1 year 6 months 2 weeks and 3 days-old Yearling Heifer; bred by exhibitor.

JOHN and ALFRED HEASMAN: the Prize of TEN SOVEREIGNS, for their 1 year 6 months and 3 weeks-old Yearling Heifer; bred by exhibitors.

PENNINGTON GORRINGE: the Prize of FIVE SOVEREIGNS, for his 1 year and 5 months-old Yearling Heifer; bred by James and Pennington Gorringe, of Tilton.

ROBERT NEAME: the Prize of TEN SOVEREIGNS, for his 6 months 2 weeks and 5 days-old Heifer Calf; bred by exhibitor.

PONIES: *of any Breed.*

GEORGE KERSEY COOPER, of Euston, Thetford, Norfolk: the Prize of TWENTY SOVEREIGNS, for his 9 years and 1 month-old Welsh Gallaway Stallion Pony; bred by David Havrard, of Defynnock, Brecon, N.W.

THOMAS NEVE, of Benenden, Staplehurst, Kent: the Prize of FIFTEEN SOVEREIGNS, for his 5 years-old Mare Pony; bred by Mr. Howell, of Manor Farm, Holme, Norfolk.

REV. W. HOLT BEEVOR, of Cowbridge, Glamorganshire: the Prize of FIVE SOVEREIGNS, for his 7 years-old Mare Pony; bred by R. N. Garne, of Nash Manor, Cowbridge.

SHEEP: *Kentish or Romney Marsh.*

FREDERICK MURTON: the Prize of TEN SOVEREIGNS, for his 2 years and 3 months-old Pen of five two-years old Ewes; bred by exhibitor.

EDWARD KINGSNORTH, of Orlestone, Ham-street, Kent: the Prize of FIVE SOVEREIGNS, for his 2 years and 3 months-old Pen of five two years-old Ewes; bred by exhibitor.

CHARLES COLLARD, of Wickhambreux Court, Wingham, Kent: the Prize of TEN SOVEREIGNS, for his 3 years and 4 months-old Pen of five three years-old Ewes; bred by exhibitor.

FREDERICK MURTON: the Prize of FIVE SOVEREIGNS, for his 3 years and 3 months-old Pen of five three years-old Ewes; bred by exhibitor.

Commendations.

The mark * signifies "SPECIALLY COMMENDED;" the mark † "HIGHLY COMMENDED;" the mark ‡ "COMMENDED" (distinctly and individually); and the omission of these marks, "GENERALLY COMMENDED" (as part of a whole class).

CATTLE: *Shorthorns.*

†JOHN HANBURY BRADBURNE, of Pipe-place, Lichfield, Staffordshire: for his 3 years 1 month and 4 days-old Bull; bred by Edmund Lythall, of Radford Hall, Leamington, Warwickshire.

†HENRY AMBLER, of Watkinson Hall, Halifax, Yorkshire: for his 2 years 8 months 1 week and 3 days-old Bull; bred by William Carr, of Stackhouse, Settle, Yorkshire.

‡THE HON. COLONEL PENNANT, M.P., of Penrhyn Castle, Bangor, Carnarvon: for his 3 years 4 months 2 weeks and 3 days-old Bull; bred by exhibitor.

‡JOHN LYNN, of Church Farm, Stroxton, Grantham, Lincoln: for his 2 years 11 months and 2 weeks-old Bull; bred by the late Robert Lynn, of Stroxton, Grantham, Lincoln.

‡JOHN TOMPSETT NOAKES, of Brockley House, Lewisham, Kent: for his 4 years 3 months and 2 weeks-old Bull; bred by his Royal Highness the Prince Consort.

†HENRY AMBLER: for his 1 and 7 months-old Bull; bred by exhibitor.

†FRANCIS HAWKSWORTH FAWKES, of Farnley Hall, Otley, Yorkshire: for his 1 year 2 months 3 weeks and 6 days-old Bull; bred by exhibitor.

‡FRANCIS HAWKSWORTH FAWKES: for his 1 year 2 months 3 weeks and 1 day-old Bull; bred by exhibitor.

‡JAMES DICKINSON, of Balcony Farm House, Upholland, Wigan, Lancashire: for his 1 year and 2 months-old Bull; bred by exhibitor.

‡LIEUTENANT-COLONEL TOWNELEY: for his 1 year 10 months 2 weeks and 2 days-old Bull; bred by exhibitor.

†JONAS WEBB, of Babraham, Cambridge: for his 9 months 3 weeks and 3 days-old Bull-Calf; bred by exhibitor.

†LIEUTENANT-COLONEL TOWNELEY: for his 8 months 3 weeks and 3 days-old Bull-Calf; bred by exhibitor.

‡JOSEPH ROBINSON, of Clifton Pastures, Newport Pagnell, Buckinghamshire: for his 9 months-old Bull-Calf; bred by exhibitor.

†WILLIAM WELLS, of Redleaf, Penshurst, Kent: for his 3 years 1 month 2 weeks and 5 days-old In-calf Cow; bred by Mr. Marjoribanks, of Bushey, Hertfordshire.

†STEWART MARJORIBANKS: for his 4 years less 2 days-old In-calf Cow; bred by Thomas Robson, of Holtby House, Catterick, Yorkshire.

†FRANCIS FOWLER, of Henlow, Biggleswade, Beds: for his 3 years 2 months 3 weeks and 5 days-old In-milk and In-calf Cow; bred by exhibitor.

†JOSHUA PRICE, of Featherstone, Wolverhampton: for his 3 years and 1 month-old In-milk and In-calf Cow; bred by exhibitor.

‡EDWARD BOWLY, of Siddington House, Cirencester, Gloucestershire: for his 3 years 3 months and 5 days-old In-milk and In-calf Cow; bred by exhibitor.

‡HENRY AMBLER: for his 6 years and 2 months-old In-milk and In-calf Cow; bred by Richard Dudding, of Panton, Wragby, Lincolnshire.

†JOHN GRUNDY, of the Dales, Stand, Manchester: for his 2 years 9 months and 15 days-old In-milk and In-calf Heifer; bred by exhibitor.

†THE HON. AND REV. T. H. NOEL HILL, of Berrington, Shrewsbury: for his 2 years 10 months and 3 weeks-old In-milk Heifer; bred by exhibitor.

†LADY PIGOT, of Branches Park, Newmarket, Suffolk: for her 2 years 9 months and 4 days-old In-calf Heifer; bred by Mr. Wetherell, of Aldborough, Darlington, Yorkshire.

†DUKE OF MONTROSE, of Buchanan, Glasgow: for his 2 years 4 months 2 weeks and 3 days-old In-calf Heifer; bred by exhibitor.

†JOSHUA PRICE: for his 2 years 5 months and 4 weeks-old In-calf Heifer; bred by exhibitor.

‡RICHARD BOOTH, of Warlaby, Northallerton, Yorkshire: for his 2 years 9 months 2 weeks and 1 day-old In-calf Heifer; bred by exhibitor.

‡RICHARD BOOTH: for his 2 years 2 months 3 weeks and 5 days-old In-calf Heifer; bred by exhibitor.

‡The HON. COLONEL PENNANT: for his 2 years 8 months and 5 days-old In-milk Heifer; bred by exhibitor.

‡EDWARD BOWLY: for his 2 years 2 months 3 weeks and 4 days-old In-calf Heifer; bred by exhibitor.

‡DUKE OF MONTROSE: for his 2 years 6 months 2 weeks and 2 days-old In-calf Heifer; bred by exhibitor.

‡JOSHUA PRICE: for his 2 years 1 month and 4 days-old In-calf Heifer; bred by exhibitor.

†THE HON. AND REV. T. H. NOEL HILL: for his 1 year 7 months 2 weeks and 5 days-old Heifer; bred by exhibitor.

†STEWART MARJORIBANKS: for his 1 year 6 months 2 weeks and 5 days-old Heifer; bred by exhibitor.

†JONAS WEBB: for his 1 year 8 months 2 weeks and 3 days-old Heifer; bred by exhibitor.

‡RICHARD BOOTH: for his 1 year 5 months and 3 weeks-old Heifer; bred by exhibitor.

‡JONAS WEBB: for his 1 year 8 months 3 weeks and 2 days-old Heifer; bred by exhibitor.

‡RICHARD STRATTON, of Broad Hinton, Swindon, Wilts: for his 1 year 2 months 2 weeks and 5 days-old Heifer; bred by exhibitor.

†STEWART MARJORIBANKS: for his 9 months 3 weeks and 4 days-old Heifer-Calf; bred by exhibitor.

†LIEUTENANT-COLONEL TOWNELEY: for his 11 months 1 week and 5 days-old Heifer-Calf; bred by exhibitor.

†LIEUTENANT-COLONEL TOWNELEY: for his 10 months 3 weeks and 6 days-old Heifer-Calf; bred by exhibitor.

‡JOSEPH PAIN, of Manor Farm, Crayford, Erith, Kent: for his 11 months and 1 day-old Heifer-Calf; bred by the late Colonel Austen, of Kippington, Sevenoaks, Kent.

‡THE HON. COLONEL PENNANT: for his 11 months 3 weeks and 3 days-old Heifer-Calf; bred by exhibitor.

‡EDWARD LUDD BETTS, of Preston Hall, Maidstone, Kent: for his 10 months 2 weeks and 2 days-old Heifer-Calf; bred by exhibitor.

CATTLE: *Herefords.*

†LORD BERWICK, of Cronkhill, Shrewsbury: for his 3 years 11 months and 6 days-old Bull; bred by exhibitor.

JOHN ELLMAN, of Landport, Lewes, Sussex, for his 3 years 8 months and 2 days-old Bull; bred by Mr. Moore, of King's Pyon, Weobly, Hereford.

†THOMAS REA, of Westonbury, Pembridge, Hereford: for his 4 years 4 months 3 weeks and 5 days-old Bull; bred by Benjamin Rogers, Grove, Pembridge.

†THOMAS REA: for his 2 years 7 months and 4 days-old Bull; bred by exhibitor.

†LORD BATEMAN, of Shobdon Court, Shobdon, Hereford: for his 3 years 3 weeks and 2 days-old Bull; bred by exhibitor.

†WILLIAM TUDGE, of Ashford, Ludlow, Shropshire: for his 2 years 7 months and 4 days-old Bull; bred by exhibitor.

†JAMES MARSH READ, Elkstone, Cirencester, Gloucester: for his 5 years 8 months 2 weeks and 5 days-old Bull; bred by the Earl of Radnor, of Highworth, Wilts.

†LORD BATEMAN: for his 1 year 11 months and 9 days-old Bull; bred by William Perry, of Cholstrey, Leominster.

‡WILLIAM TAYLOR, of Showle Court, Ledbury, Hereford: for his 1 year 8 months 1 week and 2 days-old Bull; bred by exhibitor.

†WILLIAM TAYLOR: for his 1 year 6 months and 3 days-old Bull; bred by exhibitor.

†JOHN WILLIAMS, of St. Mary's, Kingsland, Leominster, Hereford: for his 2 years 6 months and 4 days-old In-calf Heifer; bred by exhibitor.

†Lord Bateman: for his 2 years 10 months 1 week and 1 day-old In-calf Heifer; bred by exhibitor.

†Lord Bateman: for his 2 years 10 months and 3 weeks-old In-calf Heifer; bred by exhibitor.

Lord Bateman: for his 10 months and 4 weeks-old Heifer-Calf; bred by exhibitor.

Lord Bateman: for his 11 months 2 weeks and 2 days-old Heifer-Calf; bred by exhibitor.

His Royal Highness the Prince Consort: for his 8 months-old Heifer-Calf; bred by His Royal Highness.

His Royal Highness the Prince Consort: for his 9 months 3 weeks and 6 days-old Heifer-Calf; bred by His Royal Highness.

John Monkhouse, of The Stowe, Hereford: for his 11 months 1 week and 2 days-old Heifer-Calf; bred by exhibitor.

Cattle: *Devons.*

‡William Hole, of Hannaford, Barnstaple, Devon: for his 1 year 8 months 3 weeks and 1 day-old Bull; bred by exhibitor.

‡Walter Farthing, of Stowey Court, Bridgwater, Somerset: for his 3 years 7 months and 2 weeks-old In-calf Cow; bred by exhibitor.

‡John Quartly, of Champson Molland, South Molton, Devon: for his 6 years and 6 months-old In-milk and In-calf Cow; bred by exhibitor.

Horses: *Agricultural.*

†William Laws, of Little Clacton, near Colchester: for his 5 years-old Suffolk Stallion; bred by exhibitor.

‡Charles Frost, of Wherstead, Ipswich, Suffolk: for his 4 years-old Suffolk Stallion; bred by exhibitor.

†William Sanday, of Holme Pierrepont, Notts: for his 2 years 1 month and 3 weeks-old Stallion; bred by exhibitor.

‡John Foster, of Bingham, Notts: for his 2 years 2 months and 2 weeks-old Stallion; bred by exhibitor.

†Charles Frost: for his 2 years-old Suffolk Filly; bred by exhibitor.

‡Samuel Wrinch, of Great Holland, Colchester: for his 2 years-old Suffolk Filly; bred by exhibitor.

‡James Shepherd, of Cock Farm, Stoginsey, Bridgewater, Somerset: for his 4 years 1 month 2 weeks and 6 days-old Dray Stallion; bred by George Hains, Huntspills, Bridgewater.

Sheep.

†Lieutenant-Colonel Inge, of Thorpe Constantine, Tamworth, Staffordshire: for his 1 year 3 months and 2 weeks-old Ram; bred by exhibitor.

‡William Sanday: for his 3 years and 4 months-old Ram; bred by exhibitor.

‡John Borton, of Barton House, Malton, York: for his 3 years and 3 months-old Ram; bred by exhibitor.

‡Thomas Bird, of Bilton, Rugby, Warwick: for his 4 years and 2 months-old Ram; bred by exhibitor.

†Jonas Webb: for his 1 year and 4 months-old Southdown Ram; bred by exhibitor.

‡The Duke of Richmond, of Goodwood, Chichester, Sussex: 6 Entries of Shearling Rams.

John and Alfred Heasman, of Augmering, Arundel, Sussex: 3 Entries.

‡William Rigden, of Hove, Brighton, Sussex: 5 Entries.

Robert Boys, of Eastbourne, Sussex: 2 Entries.

Lord Walsingham, of Merton Hall, Thetford, Norfolk: 5 Entries.

Jonas Webb: 8 Entries.

The Duke of Beaufort, of Badminton, Chippenham, Wilts: 2 Entries.

Thomas Ellman, of Beddingham, Lewes, Sussex: 2 Entries.

Henry W. Booth, of Arlington Manor, Newbury, Berks: 2 Entries.

Sir Thomas B. Lennard, Bart., of Belhus, Avely, Romford, Essex: 2 Entries.

†Jonas Webb: for his 2 years and 4 months-old Ram; bred by exhibitor.
†Jonas Webb: for his 2 years and 4 months-old Ram; bred by exhibitor.
‡Lord Walsingham: for his 2 years and 4 months-old Ram; bred by exhibitor.
‡Jonas Webb: for his 3 years and 4 months-old Ram; bred by exhibitor.
‡Jonas Webb: 3 years and 4 months-old Ram; bred by exhibitor.
‡The Duke of Richmond: for his 1 year and 4 months-old 5 Shearling Ewes; bred by exhibitor.
‡William Rigden: for his 1 year and 4 months-old 5 Shearling Ewes; bred by exhibitor.
‡The Earl of Radnor, of Coleshill House, Highworth, Wilts: for his 1 year and 4 months-old 5 Shearling Ewes; bred by exhibitor.
‡William Gascoyne, of Bapchild, Sittingbourne, Kent: for his 7 years and 3 months-old Romney Marsh Ram; bred by exhibitor.
‡Thomas Blake, of Dymchurch, Hythe, Kent: for his 2 years 2 months and 2 weeks-old Romney Marsh Ram; bred by exhibitor.
†William Lane: for his 1 year 4 months and 2 weeks-old Cotswold Ram; bred by exhibitor.
†George Fletcher, of Shipton Sollars, Cheltenham, Gloucestershire: for his 1 year 3 months and 2 weeks-old Cotswold Ram; bred by exhibitor.
†William Lane, of Broadfield Farm, Northleach, Gloucestershire: for his 1 year 3 months and 3 weeks-old Cotswold Ram; bred by exhibitor.
†William Lane: for his 1 year 4 months and 1 week-old Cotswold Ram; bred by exhibitor.
†George Fletcher: for his 1 year and 4 months-old Cotswold Ram; bred by exhibitor.
†Robert Garne, of Aldsworth, Northleach, Gloucestershire: for his 1 year and 4 months-old Cotswold Ram; bred by exhibitor.
†Thomas Porter, of Baunton, Cirencester, Gloucestershire: for his 1 year 3 months and 2 weeks-old Cotswold Ram; bred by exhibitor.
†Edward Handy, of Sierford, Cheltenham, Gloucestershire: for his 1 year 3 months and 2 weeks-old Cotswold Ram; bred by exhibitor.
‡John King Tombs, of Langford, Lechlade, Gloucestershire: for his 1 year and 4 months-old Cotswold Ram; bred by exhibitor.
‡George Fletcher: for his 1 year 3 months and 2 weeks-old Cotswold Ram; bred by exhibitor.
‡Thomas Porter: for his 1 year 3 months and 2 weeks-old Cotswold Ram; bred by exhibitor.
‡Edward Handy: for his 1 year 3 months and 2 weeks-old Cotswold Ram; bred by exhibitor.
‡William Lane: for his 1 year 3 months and 2 weeks-old Cotswold Ram; bred by exhibitor.
‡William Lane: for his 1 year 3 months and 3 weeks-old Cotswold Ram; bred by exhibitor.

The Class of Shearling Rams, 38 entries in all, generally commended.

†Thomas Porter: for his 3 years and 4 months-old Cotswold Ram; bred by exhibitor.
†Thomas Porter: for his 2 years and 4 months-old Cotswold Ram; bred by exhibitor.
†William Lane: for his 3 years 2 months and 3 weeks-old Cotswold Ram; bred by exhibitor.
†William Lane: for his 4 years 3 months and 1 week-old Cotswold Ram; bred by exhibitor.
‡Edward Handy: for his 3 years 3 months and 2 weeks-old Cotswold Ram: bred by William Hewer, of Hill House, Northleach, Gloucestershire.
‡William Lane: for his 2 years 4 months and 1 week-old Cotswold Ram; bred by exhibitor.

The Class of aged Rams, 17 Entries in all, generally commended.

†John King Tombs: for his 1 year and 4 months-old 5 Cotswold Shearling Ewes; bred by exhibitor.

†John King Tombs: for his 1 year and 4 months-old 5 Cotswold Shearling Ewes; bred by exhibitor.

‡Thomas Beale Browne: of Salperton Park, Andoversford, Cheltenham, Gloucestershire: for his 1 year and 4 months-old 5 Cotswold Shearling Ewes; bred by exhibitor.

‡Thomas Beale Browne: for his 1 year and 4 months 5 Cotswold Shearling Ewes; bred by exhibitor.

†James and Edward Crane, of Shrawardine, Shrewsbury: for their 1 year 2 months and 3 weeks-old Shropshire Ram; bred by exhibitors.

‡James and Edward Crane: for their 1 year 3 months and 2 weeks-old Shropshire Ram; bred by exhibitors.

†Edward Holland, of Dumbleton Hall, Evesham, Worcestershire: for his 2 years and 4 months-old Shropshire Ram; bred by S. Bird, near Stafford.

†Charles Reynolds Keeling, of Yew Tree Farm, Penkridge, Staffordshire: for his 2 years 3 months 2 weeks and 1 day-old Shropshire Ram; bred by exhibitor.

†William Goodwin Preece, of Shrewsbury: for his 2 years 3 months and 2 weeks-old Shropshire Ram; bred by S. Byrd, of Lees Farm, Stafford.

‡Henry James Sheldon, of Brailes, Shipston-on-Stour, Warwickshire: for his 2 years 3 months and about 2 weeks-old Shropshire Ram; bred by exhibitor.

‡Thomas Mansell, of Adcott Hall, Shrewsbury: for his 2 years and 3 months-old Shropshire Ram; bred by exhibitor.

†Edward Holland: for his 1 year and 4 months-old 5 Shropshire Shearling Ewes; bred by exhibitor.

‡The Earl of Dartmouth, of Patshull, Albrighton, Wolverhampton: for his 1 year and 3 months-old 5 Shropshire Shearling Ewes; bred by exhibitor.

‡John Evans, of Uppington, Shrewsbury: for his 1 year and 3 months-old 5 Shropshire Shearling Ewes; bred by exhibitor.

‡Henry Matthews, of Montford, Shrewsbury: for his 1 year and 3 months-old 5 Shropshire Shearling Ewes; bred by exhibitor.

‡Henry Smith, of Sutton Maddock, Shiffnal, Shropshire: for his 1 year and 4 months-old 5 Shropshire Shearling Ewes; bred by exhibitor.

†Charles Howard, of Biddenham, near Bedford: for his 1 year 4 months and 2 weeks-old Oxford Down Ram; bred by exhibitor.

†John Bryan, of Southleigh, Witney, Oxfordshire: for his 1 year 3 months and 2 weeks-old Oxfordshire Down Ram; bred by exhibitor.

†John Bryan: for his 1 year 3 months and 2 weeks Oxfordshire Down Ram; bred by exhibitor.

Joseph Druce, of Eynsham, Oxford: for his 1 year and 4 months and 2 weeks-old Oxford Down Ram; bred by exhibitor.

†William Humfrey, of Oak Ash, Chaddleworth, Wantage, Berks: for his 1 year 4 months and 3 weeks-old West Country Down Ram; bred by exhibitor.

‡Stephen King, of Old Hayward Farm, Hungerford, Berks: for his 1 year 4 months and 2 weeks-old West Country Down Ram; bred by exhibitor.

‡Charles Howard: for his 1 year 4 months and 2 weeks-old Oxford Down Ram; bred by exhibitor.

†William F. Bennett, of Chilmark, Salisbury, Wilts: for his 6 years 3 months and 2 weeks-old Oxfordshire Down Ram; bred by John Bryan, of Southleigh, Witney, Oxon.

†John Bryan: for his 2 years 3 months and 2 weeks-old Oxfordshire Down Ram; bred by exhibitor.

†John Bryan: for his 3 years 3 months and 2 weeks-old Oxfordshire Down Ram; bred by exhibitor.

†The Duke of Marlborough, of Blenheim, Woodstock, Oxford; for his 2 years 4 months and 1 week-old Oxfordshire Down Ram; bred by exhibitor.

†William Humfrey: for his 2 years 5 months and 2 weeks-old West Country Down Ram; bred by exhibitor.

‡The Duke of Marlborough: for his 3 years 3 months and 2 weeks-old Oxfordshire Down Ram; bred by exhibitor.

†John Washbourne Brown, of Uffcote, Swindon, Wilts: for his 1 year and 5 months-old 5 Hampshire Down Shearling Ewes; bred by exhibitor.

Pigs.

‡William Bradley, Wainman, of Carhead, Cross Hills, Yorkshire: for his 3 years and 3 weeks-old Carhead white Boar; bred by exhibitor.

†Joseph Hindson, of Barton House, Everton, Liverpool: for his 3 years 3 weeks and 4 days-old small white Boar; bred by Lord Wenlock, of Escrick Park, near York.

‡Thomas Crisp, of Butley Abbey, Wickham Market, Suffolk; for his 8 months and 3 weeks-old small black Suffolk Boar; bred by exhibitor.

‡George B. Morland, of Chilton Farm, Harwell, Berkshire: for his 1 year and and 9 months-old Boar; bred by exhibitor.

†John King Tombs: for his 2 years and 3 weeks-old black and white Berkshire Sow; bred by exhibitor.

†Michael Gavins, of Fox Inn, Woodhouse Carr, near Leeds, Yorkshire: for his 4 years and 1 month-old large white Sow; bred by John Kay, of Albert-street, Woodhouse Carr, near Leeds.

‡William Hewer, of Sevenhampton, Highworth, Wilts: for his 2 years and 7 months-old black and white Berkshire Sow; bred by exhibitor.

†William Hatton, of Addington, near Leeds: for his 2 years 2 weeks and 4 days-old small white Sow; bred by exhibitor.

‡George Mangles, of Givendale, Ripon: for his 2 years and 6 months-old Yorkshire and Cumberland small white Sow; bred by exhibitor.

†Thomas Crisp: for his 1 year 8 months and 3 weeks-old Improved Suffolk small black Sow; bred by exhibitor.

‡George Turner, of Barton, near Exeter: for his 2 years and 8 months-old Improved Essex small black Sow; bred by exhibitor.

‡William Bradley Wainman: for his 2 years 11 months 3 weeks and 5 days-old Yorkshire white Sow; bred by Joseph Coates, of Halifax, Yorkshire.

‡William James Sadler, of Bentham, Calcutt, Cricklade, Wilts: for his 7 months 3 weeks and 3 days-old pure Berkshire dark-spotted 3 Sow Pigs; bred by exhibitor.

†Samuel Wiley, of Brandsby, York: for his 6 months 2 week and 4 days-old pure Berkshire white 3 small Sow Pigs; bred by exhibitor.

†George B. Morland: for his 6 months 3 weeks and 4 days-old Improved Chilton black 3 small Sow Pigs; bred by exhibitor.

IMPLEMENTS.

John Fowler, Jun., of 28, Cornhill, London: the Prize of Ninety Sovereigns, for his 12-Horse Set of Steam-cultivating Apparatus; invented and improved by the Exhibitor, and manufactured by Kitson and Hewitson, of Leeds.

Robey and Co., of Lincoln: the Prize of Ten Sovereigns, for their complete Set of Patent Steam-ploughing Tackle; invented and improved by Chandler and Oliver, of Bow, and manufactured by the exhibitors.

Wallis and Haslam, of Basingstoke, Hants: the Prize of Twenty Sovereigns, for their Four-Horse Power Patent Portable Thrashing-Machine; invented, improved, and manufactured by the exhibitors.

Philip and Henry Philip Gibbons, of Wantage, Berkshire: the Prize of Thirty Sovereigns, for their Portable Combined Double-blower Thrashing-Machine; invented, improved, and manufactured by the exhibitors.

Edward Humphries, of Pershore, Worcestershire: the Prize of Twenty Sovereigns, for his Portable Combined Thrashing, Shaking, Riddling, Barley-horning, Winnowing, and Sacking Machine; invented, improved, and manufactured by the exhibitor.

James Savory, of Tewkesbury, Gloucestershire: the Prize of Five Sovereigns, for his Portable Thrashing-Machine, with Single Blower; invented, improved, and manufactured by the exhibitor. With Patent Smutting and Cleaning Machine.

Hugh Carson, of Wiltshire Foundry, Warminster, Wilts: the Prize of Ten Sovereigns, for his Chaff-Cutting Engine, for Steam Power; invented, improved, and manufactured by the exhibitor.

James Cornes, of Barbridge Works, Nantwich, Cheshire: the Prize of Five Sovereigns, for his Hand-power Chaff-cutting Machine, with two Knives; invented by John Cornes, sen., of Barbridge, improved and manufactured by the exhibitor.

Edward Hammond Bentall, of Heybridge, near Maldon, Essex: the Prize of Three Sovereigns, for his Hand-power Patent Chaff-cutter; invented, improved, and manufactured by the exhibitor.

Richmond and Chandler, Manchester and Liverpool: the Prize of Two Sovereigns, for their Hand-power Chaff-cutting Machine; invented, improved, and manufactured by the exhibitors.

T. W. Ashby and Co., of Stamford, Lincolnshire: the Prize of Five Sovereigns, for their Four-Horse Portable Flour Mill, with French Stones; invented, improved, and manufactured by the Exhibitors.

John Tye, of Lincoln: the Prize of Five Sovereigns, for his Portable Corn-grinding Mill on four travelling wheels; invented, improved, and manufactured by the exhibitor.

Hunt and Pickering, of the Goulding Implement Works, Short-street, Church-gate, Leicester: the Prize of Eight Sovereigns, for their Corn Crusher, or Kibbling Mill; invented, improved, and manufactured by the exhibitors.

E. R. and F. Turner, of St. Peter's Iron Works, Ipswich, Suffolk: the Prize of Five Sovereigns, for his Crushing Mill for Bruising Oats, Linseed, Malt, Barley, &c.; invented, improved, and manufactured by the exhibitors.

Edward Hammond Bentall: the Prize of Three Sovereigns, for his Patent Corn and Seed Crusher; invented, improved, and manufactured by the exhibitor.

E. R. and F. Turner, of St. Peter's Iron Works, Ipswich, Suffolk: the Prize of Two Sovereigns, for their Crushing or Bruising Mill for Oats, Linseed, Malt, Barley, &c.; invented, improved, and manufactured by the exhibitors.

Edward Hammond Bentall: the Prize of Seven Sovereigns, for his Improved Oilcake Mill; invented, improved, and manufactured by the exhibitor.

Dray, Taylor, and Co. (late Wm. Dray and Co.), of 4, Adelaide-place, London-bridge, removed from Swan-lane, London: the Prize of Three Sovereigns, for their Patent Oilcake Breaking Machine for Beasts and Sheep, and Tillage Purposes; invented, improved, and manufactured by N. Nicholson, of Newark.

Edward Hammond Bentall: the Prize of Three Sovereigns, for his Oilcake Mill; invented, improved, and manufactured by the exhibitor.

Messrs. Hunt and Pickering, of the Goulding Works, Short-street, Church-gate, Leicester: the Prize of Two Sovereigns, for their Oilcake Breaker; invented, improved, and manufactured by the exhibitors.

The Trustees of W. Crosskill, of Beverley Iron Works, Beverley, Yorkshire: the Prize of Ten Sovereigns, for their Improved Yorkshire Bone Mill, for Steam or Water Power; improved and manufactured by the exhibitors.

The Trustees of W. Crosskill: the Prize of Five Sovereigns, for their

Improved Yorkshire Bone Mill, for Steam or Water Power; improved and manufactured by the exhibitors.

THE TRUSTEES of W. CROSSKILL: the Prize of TEN SOVEREIGNS, for their Improved Bone Dust Mill; invented, improved, and manufactured by the exhibitors.

MESSRS. PICKSLEY, SIMS, and CO., of Bedford Foundry, Leigh, near Manchester: the Prize of FOUR SOVEREIGNS, for their Turnip-Slicer; invented and manufactured by the exhibitors.

EDWARD HAMMOND BENTALL: the Prize of FOUR SOVEREIGNS, for his Patent Gardner's Turnip-cutter, Double Action; invented by James Gardner, of Banbury, improved and manufactured by the exhibitor.

HUGH CARSON: the Prize of TWO SOVEREIGNS, for his Moody's Patent Turnip-Cutter (No. 1), for Hand-power, on Iron Frame; invented by Edmund Moody, late of Maiden Bradley, improved and manufactured by the exhibitor.

EDWARD HAMMOND BENTALL: the Prize of FOUR SOVEREIGNS, for his Patent Prize Root-Pulper; invented, improved, and manufactured by the exhibitor.

BARNARD, BISHOP, and BARNARDS, Norwich, Norfolk: the Prize of TWO SOVEREIGNS, for their Patent Root-Pulper, for Power; invented and manufactured by the exhibitors.

EDWARD HAMMOND BENTALL: the Prize of TWO SOVEREIGNS and a HALF, for his Patent Prize Root-Pulper, for Hand-power; invented, improved, and manufactured by the exhibitor.

MESSRS. HUNT and PICKERING: the Prize of ONE SOVEREIGN and a HALF, for his Eight-knife Disc Root-Pulper, for Hand-power; invented, improved, and manufactured by the exhibitors.

SPEAR and JACKSON, Etna Works, Sheffield, Yorkshire: the Prize of FIVE SOVEREIGNS, for their Set of Hand Tools used in Hop Grounds and Hand Tillage; improved and manufactured by the exhibitors.

THE RIGHT HON. LORD LEIGH, of Stoneleigh Abbey, near Kenilworth, Warwickshire: the Prize of FIVE SOVEREIGNS, for his Field Gate; improved and manufactured by the exhibitor.

MEDALS.

E. R. and F. TURNER: a SILVER MEDAL, for their Combined Bolting, Thrashing, Shaking, Riddling, Winnowing, and Barley Avelling Machine, with Elevators; invented, improved, and manufactured by the exhibitors. Adapted for working by the three-horse engine.

WILLIAM WEEKS, of Maidstone, Kent: a SILVER MEDAL, for his Apparatus adapted for Drying Hops; invented by Patrick Simpson Punnett, Esq., of Chart Sutton, and improved and manufactured by the exhibitor.

Commendations.

The mark * signifies "HIGHLY COMMENDED;" and the mark † "COMMENDED."

*THE BUSBY AGRICULTURAL IMPLEMENT COMPANY, of Newton-le-Willows, near Bedale, Yorkshire: for their Farm Gate; invented, improved, and manufactured by J. B. Booth, Esq., of Killerby, near Catterick.

*HILL and SMITH, of Brierley Hill Iron Works, near Dudley, Staffordshire: for their Iron Vermin-proof Rickstand, 16 feet diameter; invented, improved, and manufactured by the exhibitors.

*George Foord, Engineer, of Elwick Works, Ashford, Kent: for his Rusthall School Desk; improved and manufactured by Russell and Bugler.

*The Trustees of W. Crosskill: for their general Collection of Carts and Waggons.

*John Warner and Sons, of Crescent, Jewin-street, London: for their Hydraulic Pumps, &c.

*Edward Page and Co., of Bedford: for his Chaff-Cutting Machine; improved and manufactured by the exhibitors. Adapted for hand power.

*Ashby and Co.: for their Double-action Registered Oil-cake Mill, for Sheep and Oxen; invented by Smith and Ashby, of Stamford, improved and manufactured by the exhibitors.

*Picksley, Sims, and Co.: for their One Horse Bone Mill; invented by Robert Burns, of Leigh, improved and manufactured by the exhibitors.

†Barnard, Bishop, and Barnard: for their Root-Pulper for Hand Power.

†E. H. Bentall: for his Root-Slicer for Hand Power.

†Hugh Carson: for his Chaff-Cutter for Hand Power.

†W. M. Cranston, of 58, King William-street, London-bridge: for his Wood's Improved Grass-Mowing Machine.

†Thomas Beards, of Stowe, near Buckingham: for his Eight-horse Power Portable Double Cylinder Steam-Engine; invented and manufactured by Thomas Rickett, of Buckingham. And for his Apparatus for Steam Cultivating Land; invented by the exhibitor, and manufactured by the Buckingham Castle Iron Works Company, of Buckingham.

†Thomas Kennan and Son, of 18 and 19, Fishamble-street, Dublin: for their Wire-Strainer.

†The St. Pancras Iron-Works Company, Old St. Pancras-road, London: for their Stable Fittings.

†Cottam and Co., of 2, Winsley-street, Oxford-street, London: for their Stable Fittings.

†R. H. Crisp, the India Rubber and Gutta Percha Depôt, Lincoln: for his Gutta Percha and India Rubber Straps.

†Thomas Bradford, of Cathedral-steps, Manchester, and 63, Fleet-street, London: for his Patent Washing-Machine; invented, improved, and manufactured by the exhibitor.

†Oldham and Booth, of Kingston-upon-Hull, Yorkshire: for his Six-Horse Power Bone Mill, and for his Four-Horse Power Bone-Dust Mill.

†Howard, Riches, and Watts, of Duke's-Palace Iron Works, Norwich: for their Patent American Grist Mill; invented by Amory Felton, New York, U.S. America, and manufactured by the exhibitors.

PRIZES GIVEN BY THE CANTERBURY LOCAL COMMITTEE.

E. B. Elbey, of Bowhill, Maidstone: the Prize of Thirty Sovereigns, for his Plough on the Turnrise Principle. To the Ploughman, E. Waters, Six Sovereigns.

J. Wildash, Davington, Feversham: the Prize of Twenty Sovereigns, for his Plough on the Turnrise Principle. To the Ploughman, M. Coe, Four Sovereigns.

J. Simmons, Rainham, Sittingbourne: the Prize of Ten Sovereigns, for his Plough. To the Ploughman, George Baker, Two Sovereigns.

Burgess and Key, of 95, Newgate-street, London: the Prize of Twenty Sovereigns, for their Grass-Mowing Machine; invented by J. A. Allen, of New York, improved and manufactured by the exhibitors.

William Weeks: the Prize of Ten Sovereigns, for his Kent Pattern Hop-Pressing Machine, adapted for Pressing Hops in Cloth for the Home Market; improved and manufactured by the exhibitor.

ROBERT BERRIMAN, Langrish Manor Farm, Petersfield, Hants: the First Prize of TEN SOVEREIGNS, for the best Sample of Golding Hops.

EARL DARNLEY, Thong, near Gravesend: the Second Prize of FIVE SOVEREIGNS, for the best Sample of Golding Hops.

MATTHEW BELL, Bourne Park, near Canterbury: the First Prize of TEN SOVEREIGNS, for the best Sample of any other kind of Hops.

GEORGE ELEY, Tong, near Sittingbourne: the Second Prize of FIVE SOVEREIGNS, for the best Sample of any other kind of Hops.

THOMAS WHITE, Collard, Westgate, Canterbury: the First Prize of SEVEN SOVEREIGNS, for the best-managed Sample of Golding Hops.

ROBERT BERRIMAN, Langrish Manor Farm, Petersfield, Hants: the Second Prize of FIVE SOVEREIGNS, for the best-managed Sample of Golding Hops.

HOPE THEOBALDS, Godmersham, near Canterbury: the Third Prize of THREE SOVEREIGNS, for the best-managed Sample of Golding Hops.

GEORGE ELEY, Tong, near Sittingbourne, Kent: the First Prize of SEVEN SOVEREIGNS, for the best-managed Sample of any other Kind of Hops.

MATTHEW BELL, Bourne Park, near Canterbury: the Second Prize of FIVE SOVEREIGNS, for the best-managed Sample of any other kind of Hops.

WOOL.

CHARLES COLLARD, Wickham Court, Wingham, Kent: the Prize of TEN SOVEREIGNS, for the Six most valuable Kent Fleeces, combining quality and quantity, of one year's growth.

Highly Commended.—GEORGE NEVE, Sissinghurst Castle, Staplehurst, Kent.

FREDERICK MURTON, Smeeth, Ashford, Kent: the Prize of TEN SOVEREIGNS, for the Six most valuable Long-Wool Fleeces, Kent or otherwise, combining quality and quantity.

LORD WALSINGHAM, Merton Hall, Thetford, Norfolk: the Prize of TEN SOVEREIGNS, for the Six most valuable Short-Wool Fleeces, combining quality and quantity.

Commended.—THOMAS HORTON, Harnage Grange, near Shrewsbury.

Essays and Reports.

AWARDS FOR 1859.

Class V.

The Prize of 20*l.* was awarded to Mr. Philip Debell Tuckett, of 25, Gresham Street, London, for the best Report on the Modifications of the Four-Course Rotation which modern improvements have rendered advisable.

1860.

Class I.

The Prize of 50*l.* was awarded to Mr. J. B. Spearing, of Moulsford, Wallingford, for the best Report on the Agriculture of Berkshire.

The Report by the Rev. J. C. Clutterbuck, of Long Wittenham, Abingdon, was commended.

Class II.

The Prize of 20*l.* was awarded to Professor Tanner, of Queen's College, Birmingham, for his Essay on the best period of the Rotation and the best time of year for applying the Manure of the Farm.

Class III.

The Essays in this Class were not considered worthy of the Prize offered.

Class IV.

The Prize of 10*l.* was awarded to Mr. J. Fulton, of Glasgow, for the best Essay on Recent Improvements in Dairy Practice.

The Essay by Mr. Joseph Harding, of Marksbury, Bristol, was commended.

Class V.

The Prize of 10*l.* was awarded to Mr. H. Evershed, of Gosfield, Halstead, Essex, for the best Essay on the Proper Office of Straw on the Farm.

Class VII.

The Prize of 10*l.* was awarded to Professor Tanner, of Queen's College, Birmingham, for the best Essay on the Conditions of Seed-bed best suited to the various Agricultural Crops.

Essays and Reports.—PRIZES FOR 1861.—All Prizes of the Royal Agricultural Society of England are open to general competition. Competitors will be expected to consider and discuss the heads enumerated.

I. FARMING OF YORKSHIRE.

A Special Prize of FIFTY SOVEREIGNS, offered by the President, the Earl of Powis, will be given for the best Report on the Improvement in the Farming of Yorkshire since the date of the last Reports in the Journal.

II. AGRICULTURE OF HAMPSHIRE.

FIFTY SOVEREIGNS will be given for the best Report on the Agriculture of Hampshire.

The principal geological and physical features of the county should be described; the nature of the Soil and character of the Farming in its different districts or natural divisions; its Live Stock; Implements; recent changes of Farm Management; Improvements lately introduced or still required; remarkable or characteristic Farms; the History of the New Forest should be briefly traced, and any peculiar customs connected with it described.

III. DRAINAGE.

TEN SOVEREIGNS will be given for the best Essay on the Results of Drainage at different depths on different soils as tested by the wet season of 1860, including the effect of laying down drained land flat, instead of following the direction of the ridges.

The influence of subsoiling, as subsidiary to draining, should be taken into account. The effect of variations in the drainage on the crops should be tested by ascertaining, not estimating, the yield of the several lands. A practical rule should, if possible, be deduced, which will follow the broad geological distinctions between strata, or some other definite law.

IV. THE WINTERING OF DAIRY STOCK.

TEN SOVEREIGNS will be given for the best Essay on the best mode of Wintering Dairy Stock.

V. CROSS BREEDING OF CATTLE.

Ten Sovereigns will be given for the best Essay on the general principles and results involved in the Cross Breeding of Cattle.

An account should be given of the difference produced in the offspring according as the male or female parent is of a given race, of the milking as well as fattening qualities of the half-bred stock, and of the effects produced by a second cross with the original stock, or by putting half-bred animals together.

VI.

Ten Sovereigns will be given for the best Essay on the Rearing of Calves.

The advantages or drawbacks attendant on allowing the calf to suck the cow should be discussed, the extent to which new milk should be given to weaning calves, and the best artificial substitutes for the fatty matter contained in the cream, considered; the diseases to which calves are liable should be described, and the best preventatives in respect of diet and management, together with some simple remedies suggested.

VII. HARVESTING CORN.

Ten Sovereigns will be given for the best Essay on the best mode of Harvesting and Thrashing Corn.

The comparative advantages of mowing, "bagging," and reaping wheat should be considered, in respect of labour of men and horses, in cutting, carting, stacking, and thrashing; of variations of climate; of the value of the straw; and of preparation for autumn cultivation; the best position for the stacks should be pointed out, and the comparative advantage of thrashing in the field or in the barn; the benefit derived from large barns should be reviewed in relation to their cost, and the possibility of providing a less costly substitute considered.

VIII.

Ten Sovereigns will be given for the best Essay on any other Agricultural Subject.

Reports or Essays competing for the Prizes must be sent to the Secretary of the Society, at 12, *Hanover Square, London, on or before March* 1, 1861. *Contributors of Papers are requested to retain Copies of their Communications, as the Society cannot be responsible for their return.*

Rules, &c.

RULES OF COMPETITION FOR PRIZE ESSAYS.

1. All information contained in Prize Essays shall be founded on experience or observation, and not on simple reference to books or other sources. Competitors are requested to use foolscap or large letter paper, and not to write on both sides of the leaf.

2. Drawings, specimens, or models, drawn or constructed to a stated scale, shall accompany writings requiring them.

3. All competitors shall enclose their names and addresses in a sealed cover, on which only their motto, the subject of their Essay, and the number of that subject in the Prize List of the Society, shall be written.*

4. The President or Chairman of the Council for the time being shall open the cover on which the motto designating the Essay to which the Prize has been awarded is written, and shall declare the name of the author.

5. The Chairman of the Journal Committee shall alone be empowered to open the motto-paper of any Essay not obtaining the Prize, that he may think likely to be useful for the Society's objects; with a view of consulting the writer confidentially as to his willingness to place such Essay at the disposal of the Journal Committee.

6. The copyright of all Essays gaining Prizes shall belong to the Society, who shall accordingly have the power to publish the whole or any part of such Essays; and the other Essays will be returned on the application of the writers; but the Society do not make themselves responsible for their loss.

7. The Society are not bound to award a prize unless they consider one of the Essays deserving of it.

8. In all reports of experiments the expenses shall be accurately detailed.

9. The imperial weights and measures only are those by which calculations are to be made.

10. No prize shall be given for any Essay which has been already in print.

11. Prizes may be taken in money or plate, at the option of the successful candidate.

12. All Essays must be addressed to the Secretary, at the house of the Society.

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* Competitors are requested to write their motto on the enclosed paper on which their names are written, as well as on the outside of the envelope.

Members' Privileges of Chemical Analysis.

The Council have fixed the following rates of Charge for Analyses to be made by the Consulting Chemist for the *bonâ-fide* use of Members of the Society; who (to avoid all unnecessary correspondence) are particularly requested, when applying to him, to mention the kind of analysis they require, and to quote its number in the subjoined schedule. The charge for analysis, together with the carriage of the specimens, must be paid to him by members at the time of their application.

No. 1.—An opinion of the genuineness of Peruvian guano, bone-dust, or oil-cake (each sample) .. .. 5*s.*

" 2.—An analysis of guano; showing the proportion of moisture, organic matter, sand, phosphate of lime, alkaline salts, and ammonia .. .. 10*s.*

" 3.—An estimate of the value (relatively to the average of samples in the market) of sulphate and muriate of ammonia, and of the nitrates of potash and soda .. .. 10*s.*

" 4.—An analysis of superphosphate of lime for soluble phosphates only .. .. 10*s.*

" 5.—An analysis of superphosphate of lime, showing the proportions of moisture, organic matter, sand, soluble and insoluble phosphates, sulphate of lime, and ammonia .. £1.

" 6.—An analysis (sufficient for the determination of its agricultural value) of any ordinary artificial manure .. .. £1.

" 7.—Limestone:—the proportion of lime, 7*s.* 6*d.*; the proportion of magnesia, 10*s.*; the proportion of lime and magnesia .. .. 15*s.*

" 8.—Limestone or marls, including carbonate, phosphate, and sulphate of lime, and magnesia with sand and clay .. £1.

" 9.—Partial analysis of a soil, including determinations of clay, sand, organic matter, and carbonate of lime .. .. £1.

" 10.—Complete analysis of a soil .. .. £3.

" 11.—An analysis of oil-cake, or other substance used for feeding purposes; showing the proportion of moisture, oil, mineral matter, albuminous matter, and woody fibre; as well as of starch, gum, and sugar, in the aggregate £1.

" 12.—Analyses of any vegetable product .. .. £1.

" 13.—Analyses of animal products, refuse substances used for manure, &c. .. .. from 10*s.* to 30*s.*

" 14.—Determination of the "hardness" of a sample of water before and after boiling .. .. 10*s.*

" 15.—Analysis of water of land drainage, and of water used for irrigation .. .. £2.

" 16.—Determination of nitric acid in a sample of water .. .. £1.

N.B.—*The above Scale of Charges is not applicable to the case of persons commercially engaged in the Manufacture or Sale of any Substance sent for Analysis.*

The Address of the Consulting Chemist of the Society is, Dr. Augustus Voelcker, Cirencester, Gloucestershire, to which he requests that all letters and parcels (postage and carriage paid) should be directed: for the convenience, however, of persons residing in London, parcels sent to the Society's Office, No. 12, Hanover Square, W., will be forwarded to Cirencester once or twice a week.

Members' Veterinary Privileges.

I.—Veterinary Inspection.

No. 1. Any member of the Society who may desire a competent professional opinion and special advice in cases of extensive or destructive disease among his stock, and will address a letter to the Secretary, will, by return of post, receive a printed list of queries, to be filled up and returned to him immediately. On the receipt of such returned list, the Secretary will convene the Veterinary Committee forthwith (any two Members of which, with the assistance of the Secretary, will be competent to act); and such Committee will decide on the necessity of despatching Professor Simonds, the Society's Veterinary Inspector, to the spot where disease is said to prevail.

No. 2. The remuneration of such Inspector will be *2l. 2s.* each day as a professional fee, and *1l. 1s.* each day on account of personal expenses; and he will also be allowed to charge the cost of travelling to and from the localities where his services may have been thus required. The fees will be paid by the Society, but the travelling expenses will be a charge against the applicant for professional aid. This charge may, however, be reduced or remitted altogether at the discretion of the Council, on such step being recommended to them under peculiar circumstances by the Veterinary Committee.

No. 3. The Inspector, on his return from visiting the diseased stock, shall report to the Committee, in writing, the results of his observations and proceedings, which report will be laid before the Council.

No. 4. Should contingencies arise to prevent a personal discharge of the duties confided to the Inspector, he may, subject to the approval of the Committee, name some competent professional person to act in his stead, who shall receive the same rates of remuneration.

II.—Investigations, Lectures, and Reports.

No. 1. All Members of the Society have the privilege of sending cattle, sheep, and pigs to the Royal Veterinary College, on the same terms as if they were Members of the College.

No. 2. The College have undertaken to investigate such particular classes of disease, or special subjects connected with the application of the Veterinary art to cattle, sheep, and pigs, as may from time to time be directed by the Council.

No. 3. In addition to the increased number of lectures now given by Professor Simonds, the Lecturer on Cattle Pathology, to the Pupils in the Royal Veterinary College, he will also deliver such lectures before the Members of the Society, at their house in Hanover Square, or at its Annual Meetings in the country, as the Council may decide.

No. 4. The Royal Veterinary College will from time to time furnish to the Council of the Society a detailed Report of the cases of cattle, sheep, and pigs treated in the College.

[These privileges are undergoing revision. The new regulations will be published when confirmed by the Council, in November: until then the old regulations are in force.]